SCIENTIFIC AMERICAN SUPPLEMENT. No. 1421

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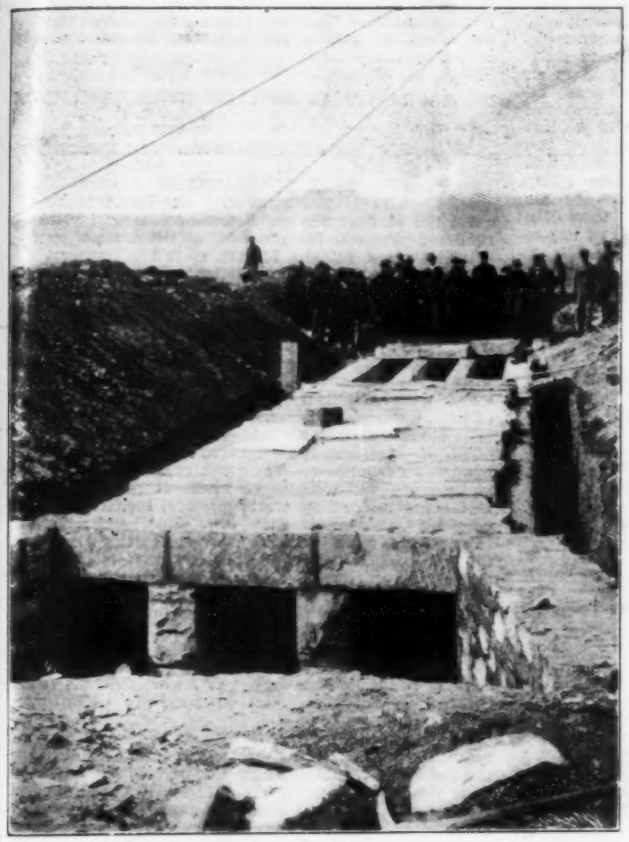
Scientific American, established 1845.
Scientific American Supplement, Vol. LV. No. 1421. NEW YORK, MARCH 28, 1903. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



BUILDING THE BULKHEAD AND WATERWAY OF THE FOSSIL CREEK RESERVOIR.

FILLING THE STORAGE RESERVOIR THROUGH A SUPPLY DITCH.

AN ARMY OF GRADERS BUILDING THE FOSSIL CREEK FLOOD RESERVOIR.

THE FLOOD RESERVOIR AT FOSSIL CREEK, COLORADO.

THE FLOOD RESERVOIR AT FOSSIL CREEK.*

By H. A. CRAFTS.

THE flood reservoir at Fossil Creek has just been practically demonstrated in Colorado. On June 1, 1902, the North Poudre Irrigation Company, of Fort Collins, completed the Fossil Creek reservoir, lying about ten miles southeast of Fort Collins, on the south side of the Cache la Poudre River. It was formed by building an immense earthwork dam across the Fossil Creek valley. The dam is half a mile long and 60 feet high, and is 210 feet thick on its bed, and 12 at the top. It took 300,000 cubic feet of earth to build the dam.

The Fossil Creek reservoir covers 750 acres and has a storage capacity of 550,000,000 cubic feet of water, or water enough to irrigate more than 12,000 acres of land. It has two principal sources of supply—Fossil Creek and the Cache la Poudre River. Being situated in the bed of the first-named stream, it naturally catches all of that stream's discharge, both normal and abnormal. The normal flow of Fossil Creek is small, but in times of a heavy rainfall within its watershed, the stream swells enormously. During a heavy storm in May, 1901, it rose at a certain point twenty-nine feet. At other points it spread over large tracts of bottom lands. There being no means provided at that time for impounding this excess of water, it flowed oceanward and was lost, as far as irrigation in Colorado was concerned.

The Fossil Creek reservoir has an inlet ditch from the Cache la Poudre River 4½ miles long, 24 feet wide on the bottom, 30 feet wide on top and 6 feet in depth. Its carrying capacity is about 500 cubic feet of water per second. The normal flow of the Cache la Poudre River is supposed to be all appropriated by irrigating ditches and storage reservoirs, whose rights are prior to those of the Fossil Creek reservoir. The only chance therefore that the Fossil Creek reservoir has of being filled is from an abnormal flow, or floodtide. Yet the owners of the reservoir expect to be able to fill it twice each year—once from the early summer floods, resulting from the melting of the heavy snows in the higher mountain ranges, and again from the excess occurring later in the season when little or no water is needed for direct irrigation.

The summer of 1902 in Colorado was one of excessive drought. The water supply derived from the melting snows in the mountains was also much below the average. During the latter part of the summer the streams were very low indeed, so there was but little water to spare for the filling of flood reservoirs.

Very little water, save some seepage water derived from its supply ditch, was received into the Fossil Creek reservoir until September 20, when the drought was broken by a sudden and violent downpour. Beginning September 20, at 5 o'clock, the storm continued until about noon on the 22d. During that time the rainfall in the Cache la Poudre valley in the neighborhood of Fort Collins amounted to 6.84 inches. This was more than had been measured at the State Agricultural College during any previous storm since a record was begun to be kept.

The discharge of the Cache la Poudre increased from 89 cubic feet per second on September 20 to 393 cubic feet per second on the 21st, and to 510 cubic feet on the 22d. The average discharge for the week ending September 23, despite the low ebb of the river for the first four days of the week, was 243 cubic feet per second, as against 113 cubic feet for the corresponding week of 1901 and a normal of 143 cubic feet.

In consequence of a heavy precipitation upon the head waters of the Cache la Poudre during the same storm, and a recurrence of additional rainfall, the flow of the river was maintained during the subsequent weeks. The discharge for the week ending September 30 averaged 250 cubic feet per second, against an average of 90 cubic feet per second for the corresponding week of 1901 and a normal of 143 cubic feet.

Now this heavy rainfall, precluding as it did the further need of irrigating the still growing crops of 1902, imparted a flow to the streams that could all be legally utilized in the filling of storage reservoirs. And there was such a generous flow that the demand for water for filling all reservoirs of prior appropriations was satisfied, and a large surplus left for the Fossil Creek reservoir. Water was received into it both from Fossil Creek and the Cache la Poudre River. Within twenty-four hours after rain began falling on September 20 the water had risen in the reservoir fourteen feet, or an addition of 44,000,000 cubic feet of water to that previously held. At the conclusion of the storm, or forty hours after its commencement, the water in the reservoir had risen seventeen feet, with a catch of over 100,000,000 cubic feet of water.

The flow of the streams being fairly well maintained throughout the remainder of the autumn, not, however, by the occurrence of any more remarkable falls of rain, the intake of water into the Fossil Creek reservoir was continued; so that January 1, 1903, the water stood 36 feet above high water mark on September 20, and the increase in the water stored was estimated at 400,000,000 cubic feet. At the same time the owners of the reservoir confidently expected to be able to fill it to its utmost capacity before the irrigating season of 1903 should open.

This experience would not only appear fully to demonstrate the feasibility of flood reservoirs, but to confirm the wisdom of the recent national legislation upon the subject. It seems probable that by the continued construction of this class of reservoirs the amount of land cultivated in Colorado may easily be doubled in area.

Dr. Philip Marvel in a paper read at a meeting of the Philadelphia County Medical Society reports that during the latter part of the summer of 1902 an unusually large number of cases of typhoid fever occurred at Atlantic City which could not be traced to the ordinary sources of infection. Persistent investigation, however, disclosed the fact that some of the oysters intended for local consumption were being freshened or fattened in a canal but a short distance from a point where sewage was being poured into the waterway; and it was also known that there had previously been cases of typhoid fever in the city whose excreta had found their way into the sewage. That the outbreak of the epidemic was actually due to the consumption of contaminated oysters seems to have been demonstrated by the fact that new cases of the disease ceased to develop after the sale of oysters and clams subjected to the freshening or fattening process was prohibited under legal penalty.—Druggists' Circular and Chemical Gazette.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

MOTHER-OF-PEARL INDUSTRY.

THE mother-of-pearl industry, as it is now known, was founded in Thursday Island, North Queensland, nearly thirty years ago, a certain Mr. Jardine, who still resides near the island and continues to hold interest in pearl fisheries, being the pioneer.

While employing Australian natives for the collection of sea slug—better known as "bèche de mer"—Mr. Jardine came across quantities of large pearl oysters on that coast, and, having no knowledge of their value, shipped a small quantity to Sydney for a report. The reply he promptly received was to abandon the bèche de mer and center all his energies on the collection of the shell. In carrying out these instructions, difficulties arose. It was soon discovered that to procure the shell in quantities was impossible with the means at hand, owing to the depth of the water in which the oyster existed. An attempt was finally made with an "air pump," the diver going down with only the helmet and receiving the air through a tube. By this means, he was able to remain on the bottom sufficiently long to collect a small bag of shell.

Singapore has been from that time the center for labor and supplies of every description, being the nearest and cheapest port of call for all the necessaries of the industry. It is also an excellent market for the shell, and more pearls probably change hands here than in any other place in the world, large quantities being purchased for the Chinese market, where there is a great demand for second-class pearls.

This report refers entirely to the shell known in the market as "mother-of-pearl," a large oyster varying from 6 to 15 inches or more in diameter and weighing from 2½ to 10 pounds, known to exist only in the waters of Thursday Island, along North Queensland, West Australia, Burma, New Guinea, the Philippines, and the Arafua Sea.

A small oyster, very productive in pearls, is found on the pearl banks of Ceylon, but is only caught for its pearls, the shell being of no marketable value. Other grounds productive of small shells are the Persian Gulf, Shark's Bay, Egypt, and (a few) Japan, but none are classed in the market with those above described. A black-edged shell, resembling in every way the one referred to, is found in New Caledonia and Tahiti. The Fiji Islands are also productive of shell, but are not much worked.

Small vessels of from 12 to 15 tons have proved the most convenient; they are rigged fore and aft and are decked over, except a hatch 6 by 4 feet in the center. The pump is firmly fixed on the bottom floor, the top being level with the top of the hatch. One boat can only work one pump. In cases where a pearler has one boat, only sufficient room will be found for the storage of shell of one month's work (this should average three-fourths of a ton), but a plant of two or more boats has generally a schooner of from 30 to 75 tons as a storeship for shell and provisions, etc. On board this schooner the shell is opened, cleaned, and packed for the London market, each diver usually giving in his portion every evening. The schooner follows the boats.

A boat's crew consists of the diver, his attendant—better known as tender—and four sailors. The work of the tender is solely to attend to the diver and the gear. The sailors man the boat and work the pumps. The diver always selects his own tender. An interference on the part of the employer in this should be avoided, as the slightest neglect of signals might cause serious consequences. He is always paid by results. The best divers are Japanese; but Filipinos are also good, and Malays find employment.

The pumps used have a rotary motion and have three chambers. The upstroke draws the air into the chambers and the downstroke presses it into a strong rubber pipe, which is fastened to the pump on deck and to the helmet on the man below, he being able to regulate the air valve himself. Great care is necessary that the men working the pump do not get negligent, and special caution is needed to see that the rubber pipes and dresses are kept in good condition.

The very best of gear should be used, inferior quality involving loss of time and consequently loss of shell. A dress lasts about four months with constant use; but using it alternately with another, means economy. The rubber piping will last about three years if carefully cleaned and dried after use. A pump, with care, will be good for many years.

The diver takes with him a bag of coir rope one-fourth of an inch in diameter, made in large meshes, that, while suited for holding the shell, does not impede his traveling along the bottom. When the bag is full he signals, and an empty bag is sent down and the full one sent up. When the shell is found in depths of water varying from 8 to 15 fathoms, the diver goes on for two or more hours; but at greater depths than this he can not remain on the bottom more than about fifteen minutes, as the pressure of water from the outside and of the air inside the dress averages at 20 fathoms 60 to 65 pounds to the square inch, and soon causes paralysis.

To lessen the work of searching, the variety of bottom can be ascertained by casting the lead with either soap or tallow stuck on the end.

Mother-of-pearl shell is generally found in strong currents and narrow channels between groups of islands. It lies on hard bottom; mud or sand being unproductive. A rocky or stone bottom is a good indication, and clay and sand are also productive when accompanied with sea grass or shaded seaweeds; but if no sponge or vegetable substance is noticed on the soap on the casting of the lead, the prospects of shell are poor.

Mother-of-pearl shell are classed under different heads and sorted for sale accordingly.

1. Bold; a very thick shell; price £120 to £150 ($584 to $730).
2. Bold to medium; a medium thickness and fairly fine in quality; price, £100 to £120 ($486 to $584).
3. Bold to fine; thick, clean, and of good color; price, £120 to £160 ($584 to $778).
4. Chicken; thin, fine, of good color, and without defect; price, £130 to £200 ($632 to $973).
5. Grubby; much eaten at the back by grub; generally thick shell; price, £80 to £100 ($389 to $486).
6. Silver lip; all pure white luster.
7. Gold lip; white center and yellow edge.

The shell are sent to London and sold at bimonthly auctions, finding their way ultimately to Sheffield for knife handles, and to other places. A quantity is purchased for the American markets.

The average value of pearls to the ton of shell is calculated at £40 ($194), but much more can be realized with good judgment in cleaning and sorting. A large quantity of "baruck" (irregularly shaped pearls) can often, by careful manipulation, be made of the best shape.

PHOTOGRAPHY AS APPLIED TO ILLUSTRATION AND PRINTING.—II.

By J. D. GEDDES.

PHOTOGRAVURE.

HISTORICALLY, photogravure or heliogravure is quite the earliest process of photomechanical printing rendered practical for the uses of illustration by the printing press, and its history is full of interest for the student and experimentalist. We are, however, not concerned specially in matters historical this evening, and I am expected to explain to you only its principles, some methods and just how the process stands to-day in its relation to modern illustration.

Photo-intaglio engraving, as its name implies, is just the opposite in effect to the photo-relief blocks which were described on Monday last. The principles of working are, however, practically the same as for type blocks, the results being obtained by the employment of a photographic image in combination with bichromated gelatine. The lines or gradations of the picture are sunk below the general surface of the metal and the inking of the picture, instead of being done by means of a roller, is effected by forcing the ink into the sunk lines with a dabber; the surface of the metal representing the subject is then wiped clean, and the impression is made by pressing a soft sized paper in contact with the plate by heavy pressure; the pressure forces the paper into the inked lines or depressions forming the picture and brings away the ink—the tones of the picture being represented by dark masses of ink in the deepest depressions and by lighter gradations in the shallower portions until the surface of the metal is reached, giving pure white.

While photogravure justly stands at the head of all processes for artistic illustration, it is one which calls for more individual skill on the part of the engraver than almost any other. There is much uncertainty in the general results, and often more than one plate must be etched before a satisfactory effect is obtained; even then sometimes a good deal of help must be given to the plate by means of the burnisher, scraper, and graver, operations which remove the process from the mechanical and call for higher artistic qualities than are generally essential for other processes.

The importance of the process renders it desirable that some demonstration of its working should be given so that the uninitiated may better understand its principles, and I am glad to state I shall be enabled to show you some of the practical details this evening through the kindness of Mr. Howard Farmer, who has sent Mr. Symmonds equipped in order to render us this service. The various operations will be slower than my description, but if you will permit it, I propose to make a break in my paper at one or two intervals to tell you the essential points as the experiment progresses.

There are several methods of preparing photogravure plates, notably Fox Talbot's process, invented just about fifty years ago, and which is to-day, in practice, the principle of the most modern process; Klic's process, a modification of Fox Talbot's; Woodbury's process, which is I believe adopted by the French house of Boussod, Valadon & Co.; Waterhouse's process, in which an electrotype plate is prepared from a sand-grained gelatine relief; Dr. Albert's process, and many others, only differing in slight details from the first-named.

The operations of preparing a photogravure plate by the process founded by Fox Talbot, are as follows: The first requisite is a transparency or positive picture on glass of the subject which it is desired to engrave; the transparency may be made by the carbon process, or by any of the dry plate processes, but if the latter is used the transparency must be reversed. This positive on glass should be as perfect as possible, free from spots or defects, and full of detail. A piece of finely polished copper is next selected, and carefully cleaned with Tripoli powder and water until the surface is free from the slightest trace of grease; after drying, the plate is ready to receive a graining of powdered asphalt or resin, so that the photographic image, when etched into the plate, will have the necessary roughness or grain to hold the ink required for printing. The powdered asphalt is placed in a box with an arrangement for creating a cloud of asphalt dust within the box, depending on the kind of grain required, whether coarse, or medium, or fine. An interval of some minutes is allowed to elapse before opening a door in the side of the graining-box and placing the plate face upward for the dust to fall upon it. Three minutes is generally sufficient to insure that the copper surface is evenly coated with the grains of asphalt. The plate is then taken out and placed on a plate of sheet-iron under which is a Bunsen burner, or is held over a flame of gas, to melt the powder so that it adheres firmly to the copper. As soon as it is cold the copper

is ready for the next operation, namely, to have the gelatine resist carrying the picture transferred to it. The gelatine resist is prepared by printing an image from the transparency already referred to on a piece of sensitized carbon tissue, which is a surface of gelatine (backed with paper) mixed with some pigment like oxide of iron or carbon, and sensitized with bichromate of ammonia. The printing is carried out in the same way as for an ordinary carbon print, save that the resulting image is negative instead of positive. The printed carbon paper is immersed in water for a few minutes, and is then squeegeed to the grain copper surface, and developed with warm water until all the unacted upon gelatine is dissolved, leaving only the negative picture on the metal. This print forms the "resist" for the subsequent etching-in of the picture, and carries the whole of the gradations of tone of the picture. As soon as the print is dry (it can be dried either spontaneously, or, if the grain is asphalt, by the application of methylated spirit) the etching of the plate may be proceeded with, but it is an operation requiring some care and skill in order to secure perfect results. The etching solution is perchloride of iron, which should be pure and neutral; the strength of the solution is important. Generally speaking, three strengths of solution are required, the first tested by Baumé's hydrometer, should register 38 to 40 degrees, and only attack the deepest shadows of the plate. Four or five minutes' etching with this solution is usually sufficient, then a solution of 35 degrees replaces the first, and the etching will be extended to the middle or half-tones for another period of four or five minutes; the third strength of solution is then taken, and the etching will attack the lighter tones up to the high lights. As soon as this is apparent the etching is complete, and the plate is plunged in water and carefully washed, the resist and protection varnish removed, and the plate is ready for proofing in the press.

The graining of asphalt mentioned is commonly used for giving the etched surface a sufficient "bite" to hold the printing ink, but there are several other grains employed, notably, the mechanically ruled screen grain seen in half-tone blocks. This grain cannot be applied to the copper in the same way as resin or asphalt powder, but it can easily be added to the transparency used for printing the resist, or it can be printed on the carbon resist carrying the picture by giving it a short secondary exposure after the picture image has been printed. The advantage of the mechanical screen is that it gives a stronger grain to the plate and admits of larger and more rapid printing. Photogravure plates of this kind deeply etched may be printed from at the rate of 500 or more per hour in a copper-plate printing machine. The Rembrandt intaglio process, which, by the way, is a secret one, employs a grain of this nature, and from my observation it gives softer and smoother results than ordinary photogravure, though it lacks the brilliancy and strength of the latter. I cannot tell you how the process of Rembrandt's intaglio printing is carried out, but from experiments I have made in this direction I am inclined to the opinion that the plates are bent on to a cylinder of a machine similar to that used for printing wall papers, and that an ink composed of dextrine or starch with a pigment replaces the usual greasy ink, also that a scraper or knife is used for "wiping" the plate in the same way as in the old process of Docteur printing. I have some examples printed in this way which closely approach the Rembrandt.

COLLOTYPE.

I have on the syllabus of subjects to be considered this evening, the processes of Collotype and Woodburytype printing; either of them would supply abundance of interesting material for an entire paper, but the limited time at our disposal will admit of my giving you little more than an outline of their principles and working. The collotype process is worked universally, and is known by a variety of names; the Germans call it "Lichtdruck," the French "Phototypie," the Americans "Phototype," and we English have given it the titles of "Photo-print," "Heliotype," "Autotype," "Photophane," "Photo-mezzo-type," "Graphotone," etc.

The process is based on the well-known action of light on bichromatized gelatine, and is allied to photolithography, with this difference that in collotype the exposed image in gelatine is employed for the actual printing surface, and not only can line subjects be printed from it but copies of photographs, paintings, and drawings. It renders half-tones so accurately that when prints by collotype process are made on highly glazed paper with a suitable ink there is scarcely any perceptible difference between them and ordinary silver prints; platinotype and bromide prints can also be closely imitated. The process is largely used for the production of view books, fac-simile copies of engravings, copies of paintings, "art study" portrait work, and for commercial illustrations. I have explained in a previous paper that when a film of bichromate mixed with gelatine is exposed to light under a negative, then washed and dried, it will when treated like a lithographic stone, absorb water where the gelatine film was protected from light by the dense portions of the negative, and will take ink and form a printing surface in the places where light has obtained access to the film through the negative. A collotype plate will not only take ink where absolutely clear glass occurs in the negative, but it will take ink in the half-tone in exact gradations corresponding to the amount of light passing through the negative. This property is most valuable, and, as a matter of fact, constitutes the process.

The preparation of collotype plates is not difficult, and the operations can be described in a few minutes. The printing plate is formed of a piece of plate glass of about half an inch in thickness, ground on the printing side to give a better hold to the gelatine. In order that the film may withstand the heavy pressure of the printing press, it is found necessary to coat the plates first with a substance containing albumen, water-glass, and water. This solution is spread over the cleaned glass in a thin coating and dried. The sensitizing solution for collotype printing is composed of Coignet's gelatine 3 ounces, albumen 1 ounce, water 25 ounces, and bichromate potash ½ an ounce. The exact proportions are not arbitrary, and different operators modify their solution as experience guides. The sensitizing solution is carefully filtered through flannel, and, while warm, is poured over the surface of the "substratumed" glass plate in a fairly thick film; the coated plate is then placed on accurately leveled supports in a drying-chamber or box, and heat is applied to the bottom of the box, which is made of sheet iron. Considerable heat is required to dry the plates, and the grain or texture of the plate is affected by the speed of the drying; about four hours is the usual time occupied. When the plate is dry and cool it is ready for exposure under the negative; the qualities necessary in a collotype negative are that it must be reversed, and be of full printing strength. A negative that would render a full rich print by any silver printing process is the proper standard for collotype. The margins of the negative are masked with thin opaque paper or tinfoil, so as to permit of the picture being printed with a clean edge on paper with proper margins. The time required for the exposure under ordinary conditions, as regards light, is from twenty minutes to half an hour, but this is a matter which can only be fixed by experience. The image on the plate cannot be examined during exposure, and an actinometer scale is used for gaging the amount of light. After exposure, the plate is taken into a room lighted a dull or yellow light, and washed in running water for about half an hour in order that all the soluble unacted upon bichromate may be removed from the film, after which the plate is allowed to dry spontaneously, when it is ready for printing.

The printing may be performed in an ordinary Albion press used for letterpress printing, or in a lithographic press. For rapid printing, or for long runs, special steam driven presses are constructed, with cylinder pressure, on which it is possible to print two or three hundred copies per hour.

When the plate is fixed in position in the press, it is first wetted all over with a sponge and water, or with a solution of common salt, glycerine, and water, which, after being allowed to act on the gelatine for ten or fifteen minutes, is sponged off and the plate is rolled up with ink. If the printing is being done on a hand press, a coating of ink is applied first with a leather roller, which inks up the shadows and stronger parts of the picture. This inking is then followed by another with a gelatine roller, which inks up the half-tones and details of the subject. A sheet of ordinary printing paper is now placed over the inked surface, and pressure applied. The result is a permanent ink print on paper of the negative used. If the printing is done on a steam press, the operations are, of course, more mechanical, but the finished result is practically the same. Large plates can be successfully dealt with at machine, and pictures on paper up to 40 by 30 inches can be printed.

The collotype process has had a long and successful career, and the beauty and delicacy of its results, when properly printed, are fully equal to that of any other photo-mechanical process, but, of late years, the advances made in half-tone blocks, and more especially in the machinery constructed for printing them, has to some extent covered the ground hitherto occupied by collotype illustrations alone, and though the half-tone block can never oust or replace collotype for many kinds of illustration, yet it is sufficiently a rival to restrict its expansion and scope from a commercial point of view.

WOODBURYTYPE PRINTING.

Among all the processes for obtaining printing press pictures by means of photography, I think that of the late Mr. W. B. Woodbury is the most audacious from a purely photographic aspect. He aimed at the highest ideal, and attained it. His process is the only photo-mechanical one which, in the printing press, realizes the gradations of tone without grain or texture of any kind; and Mr. Woodbury's working out of the process was so complete, that the operations of working it stand to-day precisely as he left it. The only variations since introduced do not alter the main principle of his invention, and refer more to mounting and transferring of the printed results than to the process itself. The idea of the process emanated from the carbon print, in which the picture is formed in all its gradations by various thicknesses of pigmented gelatine, the shadows, representing the greatest thickness, being in relatively high relief, and the high lights the lowest. Reasoning backward, Mr. Woodbury conceived the idea of making an electrotype mold of a carbon picture, and using the mold so obtained as a printing surface by covering it over with warm pigmented gelatine, and by flat pressure attaching a sheet of paper to the pigment, so that when the gelatine jelly was set he could detach it from its mold and thus by repeating the operation obtain unlimited copies. This was practically the Woodburytype; but of course there were difficulties and imperfections, which the inventor quickly set to work to overcome. He found that a thick film of gelatine and bichromate, when exposed under a negative and washed, gave a very high, sharp relief; and he also found that when this relief was perfectly dry it possessed the property of being absolutely incompressible, in other words, it was as hard as steel, and could be used as a die. The relief film of gelatine was placed on a block of smooth, hardened steel, with raised edges, upon this was laid a sheet of type metal or lead about a quarter of an inch thick, and the arrangement was then placed under a hydraulic press capable of exerting a pressure of about 40 cwt. to the square inch. The pressure forced the lead into the gelatine image with such accuracy that every shade and detail of the relief was impressed. The raised edges round the steel block prevented the metal from squeezing out, and on being detached, a mold in lead was obtained which could be used as a printing surface for thousands of copies. The seemingly delicate relief in gelatine was quite uninjured by this treatment, and would serve for any number of further pressed molds.

The printing press for these pictures is special, but quite simple. It is formed of a cast-iron base, on which is fitted a movable table to hold the mold, which is bedded down on to it with gutta percha; over the table is a hinged lid, faced with plate-glass, with a lever attachment for giving the pressure. The printing ink is a solution of gelatine in a hot state to which a pigment is added to give any desired tint.

In printing the lead mold is first oiled to prevent the gelatine sticking, and a pool of the warm ink is poured on to the middle of the mold; over this pool is laid a sheet of paper waterproofed with shellac, and the lid of the press is brought down over the whole, and pressure applied. The pressure squeezes out over the edges of the mold all superfluous ink, and all that is left is that retained in the graduated hollows and depressions of the lead mold; the warm ink sets in a few minutes, and on opening the press the paper support is removed with its gelatine copy of the molded picture firmly attached to it. This is the Woodburytype print, and it only requires drying and dipping in a bath of alum to render it absolutely permanent. The beauty and finish of these prints is beyond question, and the only drawback to them for some purposes is that they must in all cases be mounted before they can serve as book or other illustrations. There is no means of printing them directly on paper with a margin, though this difficulty has been surmounted in a roundabout way in transferring the thin gelatine pictures to prepared plate paper.

The Stannotype process is a modification of the Woodburytype, and was also invented by Mr. Woodbury. It has almost gone out of use now, and it will be sufficient if I explain that the printing is done direct from the gelatine relief by covering it over with a thin foil of tin. The foil prevents the wet gelatine ink from actual contact and destroying it. The printing is carried out in the same way as for the Woodburytype. —Journal of the Society of Arts.

THE NEW RIFLE FOR THE BRITISH ARMY.

THE rearming of the British army with a new rifle is to be carried out at once, and all the plant at the various government arsenals is to be transformed with all possible dispatch to manufacture the new weapon. The transition is a sudden one, and all work upon the present type of rifle is stopped and the products abandoned. The new arm to be adopted is known officially as the "Lee Enfield Modified," and therein are incorporated many improvements and advantages. The weapon is five inches shorter than the Lee Enfield rifle at present in use, which will result in an appreciable reduction of weight. In fact, the weapon may most aptly be described as a compromise between a rifle and a carbine. Another feature is that the barrel is inclosed in a wooden casing throughout its entire length up to within an inch of the nozzle. In the present Lee Enfield rifle, there is a small wooden grip for the left hand, to afford protection from the heat of the barrel generated by rapid and continued firing, but the experiences of the Boer war proved that this protection is quite inadequate. The provision of this wooden casing on the barrel has necessitated an alteration in the device for fixing the bayonet. A nose cap is to be fitted, to which the bayonet is to be attached. There are several other modifications in the weapon, the most important of which is that at about ten inches from the nozzle of the rifle the bore is very slightly enlarged, and the enlargement continues right up to the nozzle. By this arrangement greater velocity of the projectile will be obtained, since at the point where the bore commences to increase, the force of the explosion of the cartridge has been expended, while if the bore continues to be the same diameter thereafter to the muzzle, the tight barrel means increased friction and reduction of velocity, whereas by enlarging the bore a very small fraction of an inch, the friction will be reduced and increased velocity obtained.

By diminishing the length of the barrel, however, the back and fore sights are brought closer together, which arrangement will entail greater care in taking aim, since the possible angle of error will be greatly increased. The back sight also is different from that at present in vogue, and is in fact the only part of the weapon which projects above the wooden casing. The flap is large, and is capable of adjustment up to a considerable range without being raised. The mechanism of the weapon is much simpler than the existing rifle, while the number of parts is less, which renders the arm less liable to derangement. The magazine, which will be completely concealed within the stock, will still carry ten cartridges, as is the case with the Lee Enfield; but instead of loading the magazine by hand as is now the practice, and which is very unsatisfactory and slow, a clip will be employed as in the Mauser rifle. Altogether, the new arm is claimed to be superior in every way to any other rifle at present in use.

THE REBUILDING OF JERUSALEM.

AN interesting communication regarding the rebuilding of Jerusalem has been made by Major-General Sir C. W. Wilson, who has been engaged in the excavation work of the Palestine Exploration Fund. According to this authority Hadrian on the suppression of the rebellion, was able to carry out his project of rebuilding Jerusalem; and in A. D. 136, the year in which he celebrated his "vicennalia," the new city was dedicated to Jupiter Capitolinus, and made a Roman colony under the title "Colonia Ælia Capitolina." The size of the city is unknown, but it was probably surrounded by a wall which excluded the southern portion of the western spur and included the traditional sites of Golgotha and the Tomb. Hadrian adorned the new colony with magnificent buildings, for which much of the material was obtained from the ruins of the Temple, palaces, etc. On the site once occupied by the temple of Jehovah, the Emperor erected a temple of Jupiter Capitolinus, and within it placed statues of himself and of Jupiter, who was regarded as the guardian deity of the city. Among other buildings attributed to Hadrian are two public baths, a theater, two market places, a Trikameron, and others called Terranymphon, Kodra, and Dodekapylon. On the gate which led to Bethlehem was sculptured a boar, the fifth in rank of the "signamintaria" of the Roman army, and probably

connected with the Tenth Legion. The constitution of Ælia was that of a Roman colony; and the city was divided into seven quarters, each having its head man. Jews were excluded by stringent laws. They were forbidden to enter under pain of death. Guards were stationed to prevent their entrance, and they were not allowed even to gaze upon the city even from a distant height Pagans and Christians alone were allowed to reside in the city, and the magnificence of the colony was of an essentially Pagan character. The chief religious worship was that of Jupiter Capitolinus, but on the coins Bacchus, Serapis, Venus or Astarte, and the Dioscuri are represented as deities of the city. When or by whom the later temples were erected it is impossible to say. On the ground now occupied by the Church of the Holy Sepulcher stood a temple with regard to which there appear to have been two distinct traditions—one Greek, the other Latin. The first is that unknown persons erected a temple of Aphrodite above the Tomb of Christ, the second that Hadrian set up (whether in a temple or not it is not directly stated) a statue of Venus on the spot where Christ suffered and a statue of Jupiter above the Tomb. The Greek tradition is in general agreement with the statement of Eusebius (A. D. 260-339) the only writer on the subject who could have seen the Temple before it was demolished to make room for Constantine's churches. In his "Life of Constantine" Eusebius says that certain ungodly and impious persons covered up the Tomb and built, on a paved floor above it, "a gloomy shrine" to Aphrodite, thinking that they would thereby conceal the truth. Sozomen (375-450) states that the Tomb and Golgotha were covered up by Pagans who had formerly persecuted the Church, and that the whole place was inclosed by a wall and paved. The Pagans erected a "temple" to Aphrodite, and set up "a little image," so that those who went to worship Christ would appear to bow the knee to Aphrodite. Socrates relates that those who hated Christianity covered the Tomb with earth on which they built a temple of Aphrodite with her image. In the later tradition of Alexander Monachus, who wrote in the sixth century, the holy places are covered up by the Jews, and the temple and statue of Aphrodite are the work of idolaters of later dates.

SUPERHEATED STEAM FOR LOCOMOTIVES.

ALL engineers who occupy themselves with traction upon great railway lines must have noticed, in the German section at the Vincennes annex, during the Exposition of 1900, a locomotive, the smoke box of which presented an external aspect very different from that of the other locomotives exhibited. This engine (Fig. 1), built by the Borsig works at Berlin, and very well elaborated in all its details, was provided wth two coupled axles, a front bogie, and two simple-expansion cylinders; and was designed for hauling express trains upon the German lines. But what differentiated it from other locomotives, compound or simple-expansion, was the use for the latter of superheated steam, that is to say, of steam which, after having been produced in a state of saturation in the boiler at the working pressure of the latter, was afterward superheated in a reservoir placed in the smoke-box, so as to elevate its temperature a hundred degrees above the temperature of saturation, without, however, increasing the working pressure of the boiler. It is this superheated steam that afterward actuates the pistons of the cylinders.

As is well known, the use of superheated steam presents numerous advantages, the most important of which we shall point out. In the first place, in consequence of its high temperature, when such steam is introduced into the cylinders, the reduction of its temperature resulting from its contact with the cold walls of the latter, causes no condensation thereon. There is consequently no increase in the output of steam, as there is when saturated steam is used.

Afterward, as a consequence likewise of the superheating, the saturated steam increases in volume, with the result that one kilogramme of coal produces, at a pressure of twelve kilogrammes, for example, and with a superheating of 100 deg. C. above the temperature of saturation, a volume of steam about 15 per cent greater than that produced by twelve kilogrammes in the state of saturation. As the work is proportional to the volume of steam employed, the result is a saving in the consumption of steam and coal. As for the quantity of coal necessary for such superheating of the steam, that is small and represents but 10 per cent of the total heat requisite.

Another advantage of superheated steam is the slight resistance that it offers to the travel of the piston during the period of compression, in consequence of its slight density. The engine runs with greater ease at high speeds.

The consequence of these different important facts is that, with a given boiler, it is possible to obtain a greater power, or, inversely, that in order to obtain a given power, it is possible to make use of a lighter boiler and one of less capacity. Such is the principle of the use of superheated steam. The importance of it can be seen, especially for railway traction, since the loads hauled are becoming heavier and the running speeds still higher. The use of superheated steam has in recent years notably increased in stationary engines, especially in Germany, and very carefully performed experiments have shown that a great saving is thereby effected, notwithstanding certain complications necessitated by the installation of the superheating apparatus. In view of such results, it was very natural to ask whether the same advantageous results could be obtained by applying superheated steam to locomotives. This was the problem that the Prussian State Railways desired to solve through the construction of

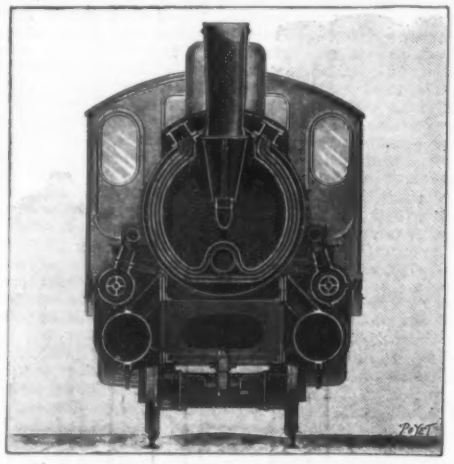


FIG. 3.—TRANSVERSE SECTION OF THE BOILER.

the engine under consideration. The superheating apparatus employed is that of Schmidt. As shown in Figs. 2 and 3, it consists of a large pipe placed horizontally at the lower part of the boiler. One end of this pipe terminates in the fire-box, and the other in the smoke-box, in a casing at the bottom of the latter. A portion of the hot gases derived from the combustion in the fire-box traverses the horizontal pipe and the casing in the smoke-box, and afterward escapes into the smokestack through apertures formed for the purpose, the section of which can be properly regulated according to the temperature of superheat to be obtained. In passing into the casing at the bottom of the smoke-box, the hot gases impinge externally upon a series of tubes forming a spiral, through which passes the saturated steam coming from the boiler. During its passage through this spiral, the steam is superheated by about 100 deg. C. above its temperature of saturation before it passes to the steam chest of each of the cylinders.

In 1901, this locomotive was compared with two others, one a two-cylinder compound, and the other a four-cylinder compound of the last type studied by Herr von Borries. These three engines, of nearly equal power, performed the same service and hauled loads regulated according to the power of the boilers, with a mean consumption of 400 kilogrammes (880 pounds) per square meter of grate surface. It results from these comparative trials that, from an economic standpoint, i. e., from the standpoint of the effective horse power produced per one kilogramme of coal or of that produced per one ton of locomotive weight, without taking account of the tender, the superheated steam locomotive was nearly equivalent to the two-cylinder compound locomotive, but clearly inferior to the four-cylinder compound one. Such equivalence, without any marked advantage, of the superheated steam locomotive and the two-cylinder compound one, seems to show that it would be possible to obtain a certain advantage from the use of superheated steam by combining it with the compound principle, thus benefiting from the advantages of such a system. Such an experiment, unfortunately, has not been made, but it certainly will be in the near future, after the experiments now being tried have resulted in the designing of a simple superheater, the wear and cost of maintenance of which will remain within practical limits and the construction of which will allow a constant temperature of superheating to be preserved, which is something that does not appear to be the case with the Borsig locomotive.

It must not be forgotten, either, that over and above considerations (certainly very important) of economy in steam by use of the compound system with the addition of superheating, account is to be taken of the stability of running at very high speeds, and that from this standpoint the compound locomotive, with four cylinders distributed in two groups, offers the immense advantage of diminishing the stresses that the motive parts have to support by distributing such stresses between the two groups and, so to speak, completely balancing the masses in motion.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

HOW IRON ORE IS HANDLED IN THE UNITED STATES.

THE wonders accomplished in the mining and handling of iron ore in the United States by the application of modern machinery are outlined in a special report to the British government made by the acting British Consul at Chicago, Mr. T. Erskine, a copy of which has been received by the Treasury Bureau of Statistics. The report is entitled "Report on the Iron Ore Industry of the United States," but gives especial attention to the modern methods of mining and handling ore, by which hand labor has been greatly reduced. In mining ore in certain parts of the Lake Superior region he says that the top covering of ground rock is scraped off over the whole property before mining begins. Railroad tracks are then laid direct to the ore bed, and the ore is loosened by blasting. Steam shovels are then brought into use, and they load the ore directly upon the cars, one of these machines having loaded 170,000 tons in 26 days, or at the rate of over 6,500 tons per day. These loading machines, which daily handle more than 6,000 tons, are each operated by five men, and the labor cost for mining and loading averages but about 16 cents per ton, and in the case of one mine which dug and loaded 293,651 tons in 174 days, the labor cost was only 4 cents per ton.

In the transfer of ore from mine to vessel on the lakes, the absence of hand labor is also noticeable. The ore trains are run onto long docks extending high above the water, and having large pockets or apartments into which the ore is discharged from the cars through an opening in the bottom of the car, from which the ore runs by gravity into the pockets beneath the tracks. From these pockets the ore is loaded into the vessel, also by gravity, and passed down long chutes into the hold of the vessel, so that no hand labor is required in transferring the ore from the cars to the vessel. The ore pockets or apartments, which form a part of the dock, hold about 160 tons each, and number from 90 to 384, according to the length of the dock.

In unloading the ore from the vessels, the saving of labor through the use of machinery is even more notable and important in its economies and results. A series of steel bridges, so adjusted as to be easily moved along the docks, is supplied with a hinged arm, which can be lowered to the hatch of the vessel. Along this arm and across the bridge runs a trolley train to which are attached automatic "grabs" similar to a double scoop, which are so constructed that the grab or scoop digs downward into the ore as it closes. The grab or scoop holds about 5 tons of ore and is described as a "digging machine," as when it begins to draw together it digs into the ore and does not depend on its weight to get hold of the ore. There are fifteen unloading machines in a battery, and the grabs run down the long arms, which are lowered over each of the fourteen hatches that are in the deck of most lake vessels carrying ore. These hatches run nearly the whole way across the decks. The grabs can thus remove over half the cargo without any assistance, and the remaining half is brought directly under the hatch by use of a scraper, also operated by similar machinery and managed by a man in the hold through the use of long cords. This scraper brings the ore from between the hatches, so that it can be raised by the grab. These grabs are controlled by the engineer, who can drop them at any point over the hold that he may wish, and after it seizes its load of ore, it is raised at full speed, carried rapidly along the trolley to such given point as desirable, where the ore is deposited into railroad trucks or stock piles, or in some cases into concrete troughs, through which it slides to the furnaces, where it is to be transferred into pig iron. This grab, which thus lifts five tons of ore from the vessel, carrying it to such point as is desired within a limited space, has a hoisting speed of 100 feet a minute, and can run along

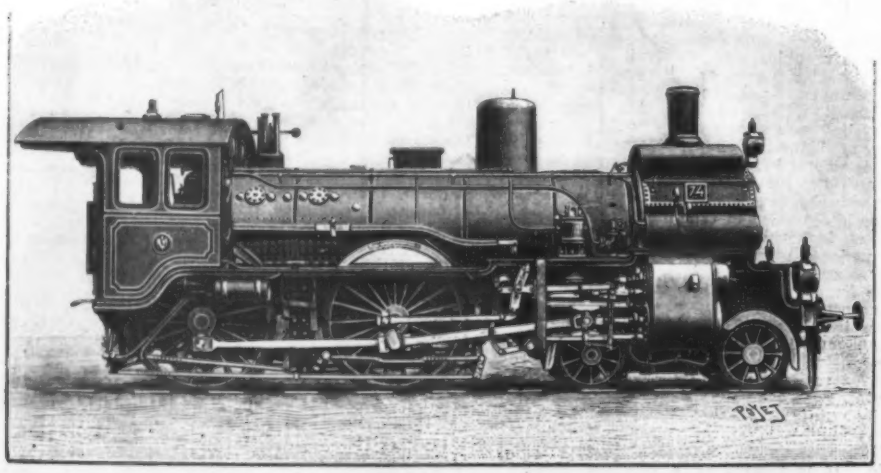


FIG. 1.—GENERAL VIEW OF A SUPERHEATED STEAM LOCOMOTIVE.

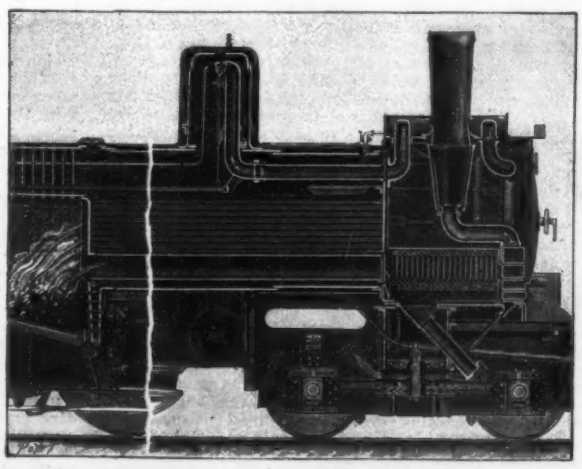


FIG. 2.—LONGITUDINAL SECTION OF THE BOILER.

the bridge at the rate of 1,000 feet a minute. The operator travels with the grab, and can unload it at any given point desired. The bridges to which these arms with their grabs are attached can be swung in any direction, so that ore, limestone, or coke can be deposited or picked up anywhere in the yard, and are worked by electricity. Twenty-six men will now perform, under this system, the work for which 300 were required under the old system.

[Continued from SUPPLEMENT No. 1420, page 22762.]

HIGH TEMPERATURE ELECTRO-CHEMISTRY: NOTES ON EXPERIMENTAL AND TECHNICAL ELECTRIC FURNACES.*

By R. S. HUTTON, M.Sc., Associate, and J. E. PETAVEL, Associate Member.

ALUMINIUM.†—Since 1889 the only two processes in actual use for preparing this metal are those of Héroult and Hall, the former being confined to Europe, the latter to America. These two methods, the chemical and electrical nature of which seem to differ very little at the present time, consist essentially in the electrolysis of fused cryolite, to which Al_2O_3 is added as the separation of aluminium proceeds.

The type of furnace used in either case is that of *D*, Fig. 13, the carbon lined crucible forming one electrode, the other being made up of a number of separate carbon rods. The differences between the two methods are essentially mechanical in nature; it is not easy to obtain any detailed information, as no doubt the success of the process depends in each case upon the perfection with which some of the inherent difficulties have been overcome. The Hall process is worked by the Pittsburg Reduction Company, who have the largest output of this metal. At Niagara Falls, in the two works 10,000 H. P. are used; at Shawinigan Falls some 5,000 H. P.; while at Massena, N. Y., a new plant is being erected for 12,000 H. P. The cells in use consist of thickly carbon-lined cast-iron pots 6 feet long by 3 feet wide by 10 inches deep; these form the cathode in which the metal is collected. The anodes are some 40 in number, and each carries about 250 amperes, the E. M. F. being 5 volts; thus some 65 H. P. are absorbed in each cell, a number of the cells being connected in series.

So far as the actual electrolysis is concerned, the recent scientific work of Haber‡ is of interest; he has been able to explain the conditions necessary for satisfactory working. One of the most important factors in the expense of manufacture is the cost of purifying the bauxite, which is a hydrated oxide of aluminium, containing always a considerable percentage of silica, iron oxide, and titanic acid. The process most generally in use at the present time is that of Bayer, which is purely chemical in nature.

A method recently invented by Hall proposes the purification of the bauxite in an electric arc furnace of type *A*, Fig. 13, by heating the mineral in contact with sufficient carbon or other reducing material to remove the impurities, and leave the oxide in a fused state. The oxide after cooling is removed, and is a gray friable material easily soluble in the cryolite; it is considered that this may considerably cheapen the manufacture. The total output of aluminium can be gleaned only from very insufficient data, the companies refusing to give official statistics; however, it is said to have been approximately 7,500 tons for 1901. The yield usually obtained is about 1 pound of aluminium per 12 H. P. hours.

Sodium.—This metal has for long been produced by the Castner process,§ which is carried out at Runcorn, Niagara, in Germany and France, and consists in electrolyzing fused caustic soda; the metal being lighter than the electrolyte rises to the top and is removed from time to time. The construction of the cell is of some interest, since by an ingenious arrangement of the anode and cathode a high current efficiency is obtained. The important consideration seems to be the exact regulation of the temperature, since at already 20 degrees above the melting point the recombination of the separating sodium is said to be so active that no metal comes to the surface. Several descriptions of the technical process have been given, and the current efficiency stated to be 70 to 90 per cent. At Niagara some 120 cells, each taking 1,200 amperes at 5 volts, are in use.

A careful study of this electrolysis has recently been made by Le Blanc and Brode,‖ who prove that the primary products are sodium at the cathode and oxygen and water at the anode; they do not seem, however, to have carried out many experiments at the lower temperatures, but state that the water remaining in the fused substance reacts with the sodium produced at the cathode, thus lowering the efficiency to 50 per cent, which is considerably below that quoted for the technical process. Sodium has also been produced by the Darling¶ process, in which the fused nitrate is electrolyzed in cast iron vessels provided with a thick diaphragm of magnesia and cement, with the production of nitric acid at the anode, and metallic sodium at the cathode. Each cell takes 400 amperes, but the voltage is as high as 15 volts.

Caustic Soda.—The problem of the electrolytic production of caustic alkalies and chlorine has for long been an important one, and has already met with a large amount of success, the Griesheim-Elektron, Castner-Kellner, and Hargreaves-Bird processes being among those which are worked on a large scale; all these, however, deal with aqueous solutions, and we are therefore not concerned with them here. The direct treatment of fused salt offers considerable theoretical advantage, and several processes have been proposed, and among these we may mention the methods of Vautin, Hulin, and Acker,* all of which employ fused lead as a cathode to the sodium. The latter has been working since December, 1900, at Niagara Falls, with very satisfactory results, using some 3,250 H. P. The entire success depends on rapidly removing the sodium alloy as formed, since its diffusion into the mass of lead takes place only very slowly, and the richer alloys are unstable in presence of the fused salt. Acker has

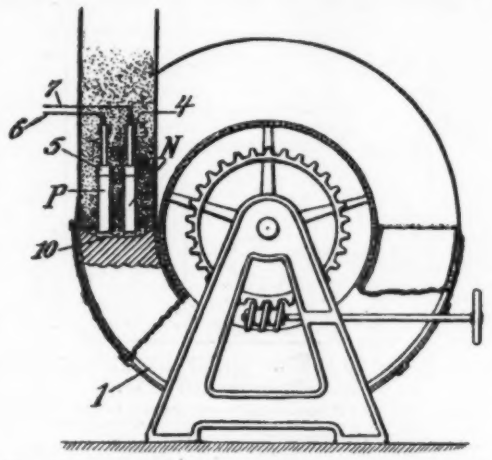


FIG. 14.—THE HORRY CALCIUM CARBIDE FURNACE.

This is essentially a furnace of type C, Fig. 13, the current passing between two vertical carbons P and N, which are fixed. On the other hand, the inclosure containing the material is automatically lowered so soon as the mixture in the neighborhood of the electrodes has been transformed into molten carbide. This is effected by constructing the furnace in the form of a drum which rotates very slowly, heating is produced in a space formed by the wide flanges of the drum, the drum itself, and plates bolted on to the periphery; these metal parts are sufficiently protected by the unacted-on material. Diametrically opposite the heating zone, at the back of the furnace, the plates are unbolted and the carbide removed. This furnace combines several of the advantages of the continuous and the discontinuous types; it is continuous in the true sense of the word since the power is never turned off, on the other hand the molten carbide is not removed until it has cooled down and imparted a considerable amount of its heat to the surrounding material. The speed of rotation of the wheel is regulated in such a manner as to keep the current approximately constant.

produced this rapid circulation by employing a steam injector, which causes the lead to flow rapidly past the anodes, and at the same time oxidizes out the sodium, producing directly anhydrous fused NaOH. The temperature at which the steam and lead alloy come in contact is already high, but is still further raised by the heat of combination of the sodium and thus of course any excess of steam passes off without combining with the caustic soda. The circulation is so good that the lead alloy in the cell does not average above 4 per cent Na. The chlorine is drawn out by a fan, and used for producing bleaching powder. The cells, which are arranged in pairs, one on each side of a central flue, are cast-iron tanks, with linings above the level of the fused lead.

Here again the inherent difficulties of furnace-linings are surmounted by leaving a sufficient coating of unfused material which protects the walls. A central channel is provided below the actual electrolytic vat, by which the lead which has been freed from its sodium is returned.

The distance between the fused lead cathode and the carbon anode is very small, and thus the internal resistance is kept low. The anodes in each cell are four in number, and are formed of graphite 7½ by 14 inches; they carry 2,000 amperes each, the voltage being 7. Forty-five cells are run in series. The anhydrous caustic formed runs over an iron lip into a receptacle placed to receive it. The current efficiency averages 94 per cent.

Zinc.—Various processes have been proposed, and some are in actual use. The recently perfected "Phœnix" process of Swinburne and Ashcroft enables zinc to be produced by the electrolysis of the fused chloride, and is of particular interest on account of its application to the treatment of complex Broken Hill ores.*

Manganese.†—In some respects very similar to the aluminium process is that recently worked out by Simon and Gin for the production of manganese. A bath of fused calcium fluoride is employed in which the oxide is dissolved and submitted to electrolysis, carbon being added to assist in the reduction. The advantage of complete regulation of the temperature is in this case of great importance, since manganese is already easily volatile at temperatures only slightly above its melting point.

Phosphorus.‡—Already in 1888 Readman and Parker perfected a satisfactory commercial process for the manufacture of phosphorus in the electric furnace. This method was tried on a large scale at the works of the Electric Construction Company at Wolverhampton, and seems since then to have been used by Messrs Albright and Wilson at Oldbury. This firm is also closely connected with the Oldbury Chemical Company, who operate a plant at Niagara Falls. The method employed is very simple, the phosphate-mineral in a finely powdered state being mixed with carbon and sand, and heated in a closed electric furnace, the phosphorus distilling off and being collected under water. Other electric furnace methods are in use at Griesheim and in France, and there is no doubt that for long the advantages of the direct-furnace treatment have been fully made use of, although few details have been allowed to escape.

Nitric Acid.§—The fascination of the direct synthesis of an important chemical compound has for long directed attention to the production of nitric acid from the nitrogen and oxygen of the air. The research of Rayleigh and Ramsey on the isolation of argon, followed by the important British Association address delivered by Crookes in 1898, helped to emphasize the importance of this subject. The careful work carried out by McDougall and Howles, which has not received the attention it deserves, was more particularly directed to a study of the efficiency of this process. By employing an alternating high-tension arc in air they succeeded, by a study of the necessary conditions, in obtaining a yield of 300 gms. HNO_3 per 12 H. P. hours, in this way combining 51 per cent of the air passed through their apparatus; while with a mixture of two volumes oxygen to one volume of nitrogen the yield rose to 590 gms. per 12 H. P. hours. In most of their experiments they used a transformer giving 8,000 volts. The work of Bradley and Lovejoy at Niagara has given more favorable results from an economical point of view. A considerable amount of preliminary work pointed out the advantage of the direct current, and the apparatus now working employs a 10,000-volt continuous-current dynamo. As will be seen in Fig. 17, the negative pole of the dynamo is connected to an axis carrying six radial arms, the positive poles being placed round the periphery of an iron cylinder which forms the combustion chamber. A choking coil is placed in each circuit. The actual apparatus comprises twenty-three such stars fixed one above the other on the same vertical axis, which revolves at the rate of 500 revolutions per minute, forming and breaking

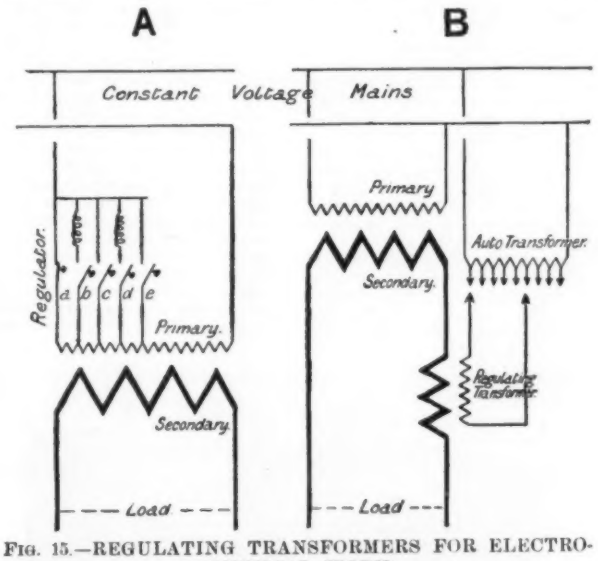


FIG. 15.—REGULATING TRANSFORMERS FOR ELECTRO-CHEMICAL WORK.

A. Shows the first method which consists in altering the transforming ratio by cutting out a certain number of the primary turns. As connected the E.M.F. of the secondary circuit would be a maximum, to reduce it the switch *B* is closed and *A* is opened, *C* closed and *B* in turn opened, each successive operation diminishing the E.M.F. by a fixed amount, the regulation being thus carried out without breaking the current.

B. Represents a second method which consists in using a boosting transformer. The current of the primary of the booster is adjusted according to the volts required in the secondary. In the diagram this is achieved by connecting it with a certain number of turns of an autotransformer placed across the mains.

414,000 arcs per minute. The chief function of this rotation is the rapid cooling down of the products of

* A paper read before the Institution of Electrical Engineers, and revised by Prof. Hutton for the SCIENTIFIC AMERICAN SUPPLEMENT.

† Wallace, Journal Soc. Chem. Industry, vol. 17, p. 308 (1898); Becker, Manuel d'Electrochimie, Paris, p. 175 (1898); Mineral Industry, p. 14 (1892); Chandler, Journal Soc. Chem. Industry, vol. 19, p. 609 (1900); W. Murray Morrison, Journal Institution of Electrical Engineers, vol. 31, p. 400 (1901); Haber, Zeitschr. fur angew. Chemie, p. 215 (1901); Richards, Electro-Chemical Industry, vol. 1, p. 49 (1902).

‡ Haber and Geipert, Zeitschr. fur Electrochemie, vol. 8, pp. 1, 26, 607 (1902).

§ English Patent No. 13,356 (1890); Electro-Chemical Industry, vol. 1, p. 15 (1902); Journal Soc. Chem. Industry, p. 777 (1891); Rathenau and Suter, German Patent No. 96,672 (1896); R. Pauli, Chemische Zeitschrift, vol. 1, p. 497 (1902).

‖ Le Blanc and Brode, Zeitschr. fur Elektrochemie, vol. 8, pp. 697-707, 717-729 (1902).

¶ Darling, Journ. Franklin Instit., vol. 153, pp. 65-67 (1902).

* Vautin, Eng. Patent 13,568, 1893; Journ. Soc. Chem. Industry, vol. 13, p. 448 (1894). Townsend, Electrical World and Eng., vol. 39, pp. 585-587 (1902). Acker, Trans. Amer. Electro-chemical Soc., vol. 1, p. 165 (1902).

* Ashcroft, Inst. Mining and Metallurgy, 1901; Electro-Chemist and Metallurgist, pp. 244-349, 269-271 (1901).

† Simon, Engl. Patent No. 17,190 of 1900; Gin, La fabrication electrique du Ferro-Manganese en France, procede Simon, Paris, 1901.

‡ Readman, Engl. Patent 14,902 of 1888; Parker and Robinson, Engl. Patent 17,719 of 1888; Readman, Journ. Soc. Chem. Industry, vol. 10, p. 445 (1891); Thorpe's Dict. of Chemistry, vol. 3, p. 192; Machalske, Electrical World and Engineer, vol. 37, p. 360 (1901); Irvine, Electrical World and Engineer, vol. 38, p. 374 (1902).

§ McDougall and Howles, Manch. Lit. and Phil., vol. 44, part 4, No 13, pp. 1-19 (1900); Bradley, Electrical World and Engineer, vol. 40, p. 159 (1902); Rayleigh, Journ. Chemical Society, vol. 71, p. 181 (1897).

the combustion, which, if allowed to remain under the heating influence of the arc would dissociate. For the same reason a rapid flow of air has been adopted, so that the issuing gases only contain about 2 to 2 per cent oxides of nitrogen. The yield obtained is 1 pound nitric acid per 7 H. P. hours. The process is considered to have already passed the experimental stage, and at the present time steps are being taken to start it on a commercial scale.

Fused Alumina.—We have already mentioned the method of Hall for purifying bauxite by fusion in the electric furnace in presence of carbon or other reducing material. Our present consideration, however, is the manufacture of an artificial abrasive by the direct treatment of bauxite. The only method, so far as is known, in actual operation is that patented by Jacobs which is now being employed at Niagara Falls by the Norton Emery Wheel Company, for long known as important manufacturers of abrasive articles of natural corundum. It has been found that the electric furnace product possesses advantages over the best grades of natural material. The bauxite is first thoroughly calcined in ordinary furnaces, and is then heated to fusion in an arc furnace of type B, Fig. 13. The plant at present in use, which is about to be further extended, employs some 500 H. P. and produces daily from 4 to 5 tons of fused alumina, called "alundum" to distinguish it from corundum. The material exhibits at times considerable crystalline formations.*

Baryta.—This material is being prepared at Niagara by the United Barium Company, barytes ($BaSO_4$), together with some reducing material, being treated in the electric furnace. The reaction which first takes place is as follows:

$$4BaSO_4 + 4C = BaS + 3BaSO_4 + 4CO.$$

The barium sulphide then reacting with the sulphate to give anhydrous baryta.

$$BaS + 3BaSO_4 = 4BaO + 4SO_2$$

In practice 500 k. w. tapping furnaces are in use, which yield a mixture of oxide and sulphide. These are easily separated in aqueous solution yielding a very good quality barium hydrate. The sulphide can afterward be carbonated or otherwise worked up.†

Carbon Bisulphide.—As we have pointed out previously, the electric furnace is usually employed for producing the chemical reactions which require temperatures otherwise unattainable. In the manufacture of carbon bisulphide the advantage of electric heating lies, however, in the fact that a more perfect control of the furnace temperature can be thus attained, the temperature required being very low. The method invented by E. R. Taylor for producing this substance consists in the direct treatment in the electric furnace of charcoal and sulphur. The manufacture has been carried out for some time at Penn Yan, New York, the daily output being some 10,000 pounds. The furnaces are decidedly the largest at present in use in any electro-chemical works, being some 40 feet high by 16 feet diameter. The sulphur is fed in continuously so as to rise from below the electrodes where it comes in contact with coke, which forms a resistance bridge between the carbons, in this way becoming vaporized and brought into contact with the charcoal which fills the rest of the tower; combination takes place, and the CS_2 produced is led off and condensed. By the application of this process a very considerable cheapening in the cost of production has been effected.

Steel.—The application of the electric furnace to the melting of steel, which was one of the first problems worked upon by Siemens, has been revived during the last few years in many different forms. The proposals, which not only include the manufacture of steel from pig-iron, but also the direct production by electric smelting of the ore, have led to the design of many special types of furnaces.

De Laval‡ invented an ingenious furnace for making steel in which the metal was melted by bringing it in contact with fused oxide of iron heated electrically by resistance. This method is reported to have been tried on a large scale at Trollhättan, in Sweden, but to have been a financial failure.

Stassano's§ furnace was in design somewhat similar to the blast furnace, the necessary heat being produced by the electric arc. A company was formed to work this process in Italy, but is said to have since ceased operations. One ton of metal was produced per 3,000 H. P. hours.

Harmet,‖ of the "Fonderies, Forges et Acieries," at St. Etienne, has worked out a method for treating iron ore in three stages, the carbon monoxide evolved by the reduction being partly used to heat the raw materials, while the reduced metal is transformed into steel in a separate electric furnace. Works are being erected at the present time for making use of this process.

Ruthenberg* has worked more particularly on the magnetic concentration of low grade ores and their subsequent fritting in the electric furnace.

Conley† proposes the reduction of iron ores by passing them between two high resistance plates which are kept heated by the passage of a current; the metal falls into a hearth which is also electrically heated.

Gin has brought forward a method of heating mixtures of iron oxide and sulphide ores, with production of sulphuric acid and ferro-silicon as by-products.

Keller‡ has designed a furnace which is being employed in works at Kerrousse (Morbihan).

Processes of electric melting by induced currents

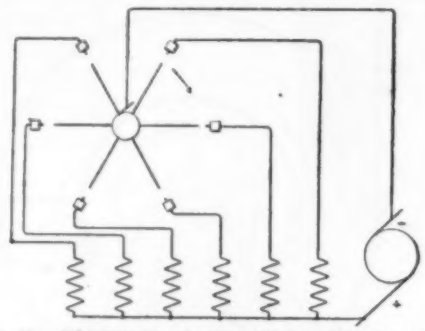


FIG. 17.—DIAGRAM OF BRADLEY NITRIC ACID PLANT CONNECTIONS.

The dynamo giving 10,000 volts has its negative pole connected with the revolving axis while the positive is connected to all the separate stationary electrodes through the choking coils 1, 2, 3, etc.
Twenty-three similar sets of stars are superimposed on the same axis. The positive electrodes are vertically one above the other; the negative electrodes, however are displaced about 2½ degrees, the arcs being thus drawn out in rapid succession.

have been proposed by Benedicks§ in Sweden and Schneider‖ in France; in both cases the metal contained in an annular crucible forms the electric conductor surrounding an iron ring, in which rapid alterations in magnetic flux are produced. Benedicks' contrivance is similar in principle to a welding transformer, the entire secondary circuit of which is formed by the molten metal. This process is in actual work at Gysinge, where 300 H. P. are employed, and 1,500 tons steel can be produced per annum. Schneider, on the other hand, produces an alternating magnetic field by the rotation of a shuttle wound armature. The outlook for these inventions can only be regarded as immediately hopeful in localities in which water power is available at an exceptionally low cost; the value of any economically successful process, however, can hardly be overestimated.

Glass.—The accuracy with which temperatures produced by electric methods can be adjusted has led to several proposals for the application of the electric furnace to the glass industry, where, as is known, the temperature regulation is one of the most important factors. Trials are being made on a commercial scale at Plettenberg (Westphalia).¶ With regard to quartz, since the temperature required is very high, the electric is the only method available for fusing this material in bulk. Considerable difficulties will have to be overcome, however, before this most valuable substance can be manufactured on a commercial scale.

Conclusion.—Although the above account is by no means exhaustive, we feel that we have already reached, if not exceeded, the limits of space which are usually allotted for a paper of this kind. In our brief review of the subject it has in most cases only been possible to describe summarily for each product one particular method of manufacture, which, however, we have tried to choose as being one worked on a large commercial scale; but it must be borne in mind that by so doing it has not been our intention to in any way detract from the value of other methods, which, although less generally used, may frequently possess advantages over those we have mentioned.

Perhaps, however, before closing we may be allowed to say a few words with regard to the theoretical efficiency of electric furnaces, about which so much has of late been written. Calculations have been made referring to each of the manufactures, but the reliability of these varies largely from case to case. When dealing with the highest temperatures very few data are available with regard to the specific heat, latent heat, or heat of combination of the various materials employed. It was previously customary to assume a constant specific heat, but more recently this has been shown to be untenable, and most of the modern calculations consider the specific heat as a linear function of the temperature, relying for their values for the higher temperatures on a very considerable extrapolation. The actual specific heats have been experimentally determined for a limited number of substances up to some 1,500 deg. C., and it is hardly necessary to insist on how considerable an error can be caused by boldly applying these values to twice the absolute temperature. In addition it must be remembered that the second factor in the calculation, the actual temperature of a furnace, is in most cases practically unknown.

The temperature of volatilization of carbon is usually taken as 3,400 deg. C., but this is no measure of the temperature of the arc flame, which may be considerably higher. On the other hand, the average temperature of the furnace is always considerably below that of the volatilization point of carbon.

The consequence of this rash way of dealing with the subject is that the estimates of the theoretical amount of heat required differ by nearly 100 per cent, as has been shown by Kershaw in the case of calcium carbide.*

With regard to those of the resistance furnaces in which the temperature is comparatively low, more accurate data can be obtained, and finally, in the electrolysis of fused salts, the calculations give a much more trustworthy result, depending as they do largely upon the electro-chemical equivalents, which are known with some accuracy.

The determination of the total loss of heat by radiation from an electric furnace provides, however, valuable information on one of the important factors in the efficiency, but the final criterion in all commercial work must necessarily be the number of tons yield per H. P. year. In describing the various methods it has been of great advantage to have means by which personal experience of the process could be obtained by direct experiment.

For this we are indebted to the foresight of Prof. Arthur Schuster, F. R. S., who, thanks to the munificence of Mr. Ivan Levinstein, was able to make ample provision for experimental electro-chemistry in the building in which we are now assembled.

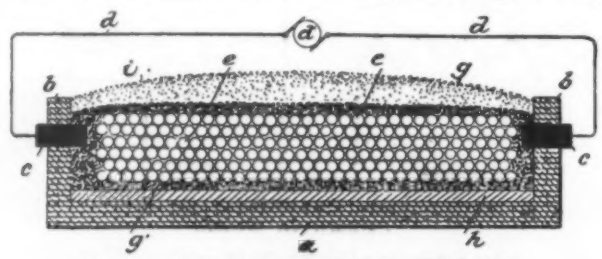


FIG. 16.—ACHESON GRAPHITE FURNACE.

This shows the furnace fitted for graphitizing electrodes; as will be seen, the current passes through the charge, which itself forms the heating resistance. The carborundum furnaces are of a similar type, but on account of the high resistance of the material are considerably shorter, and are provided with a central core of coke. Each furnace absorbs 1,000 H. P. and is run for twenty-four hours. It is capable of graphitizing 8½ tons of carbon electrodes or 6 tons of anthracite.

CONTEMPORARY ELECTRICAL SCIENCE.†

ABSORPTION OF ELECTRIC WAVES BY GASES.—That the rings in exhausted glass tubes produced in 1891 by J. J. Thomson in an alternating electric field are not due to electrostatic change, but to an absorption of electric waves by the gas, is further proved by E. Lecher by an experiment in which he winds a bifilar wire coil and a simple wire coil round the same tube, and sends strong electric oscillations through both. In spite of the high charge of the wire in both cases, a ring is only formed inside the simple coil. The author describes a method of studying the electric conductivity of gases by observing the luminous phenomena thus produced. It consists practically of a vessel resembling a Bunsen ice calorimeter, the secondary coil being placed in the interior and the primary coil outside, with the gas or electrolyte in question filling the space between. The author finds that at a pressure of about 0.1 mm. the air conducts much better than the best electrolytes. Such a pressure exists at a height of about 40 miles in the atmosphere. It is, therefore, evident that the upper atmosphere is very likely to absorb long Hertzian oscillations coming from the sun. It also explains the electric discharges often accompanying the fall of meteorites.—E. Lecher, Physikal. Zeitschr., October 10, 1902.

ATMOSPHERIC ELECTRICITY.—A large amount of new material for the study of atmospheric electricity has been brought out by the last conference at Göttingen (May 15 and 16). F. Exner reported upon the activity of the stations established by the Vienna Academy at Vienna, Trieste, Kremsmünster and the new station on the Sonnblick. The instruments used were mechanical registering instruments for atmospheric potential and electric dissipation, working for eight days without attendance. At Vienna, the negative dissipation was in excess on 67 per cent of the days, and, curiously enough, the direction of the wind appeared to be without influence, though the observatory was at one end of the city. The Kremsmünster records appear to show a simple diurnal period of potential. They also show that the latter is strongly influenced by rain, but not perceptibly by snow. No relation could be found between the dissipation and the actinic power of the sky. At Innsbruck, the positive dissipation exceeded the negative. H. Ebert reported having found radio-activity in the air of a cellar whose walls contained no radio-active substance. J. Elster reported having obtained radio-activity even on positively charged wires, but 30 times feebler than on negatively charged ones.—Physikal. Zeitschr., October 15, 1902.

NATURE OF THE POSITIVE ELECTRONS.—If the electron has an invariable charge, and a positive ion is always a single atom from which an electron has been split off, it is reasonable to suppose that the positive electron will also have an invariable charge. It should, therefore, show a ratio e/m varying only with the atomic weight, and the ratio should change from one substance to another in a manner solely depending upon the known atomic weight of the substance. W. Wien has for some time been endeavoring to discover such a regular variation in the canal rays. (See The Electrician, vol. xlxix., p. 332.) But all the experiments hitherto made result in showing that there is no abrupt transition from one value to another. The "specific charge," as the author calls the ratio e/m, may be anything from 750 to 10 millions. For both hydrogen and oxygen it figures at about 10,000. This would be the correct figure for hydrogen in the ordinary electron theory, and the author thought that the same value obtained in oxygen might be due to impurities of hydrogen. But the purification of the oxygen led to no more decisive result. We must, therefore, either assume that the positive electron can be bound to a number of material molecules, or that it can be subdivided.—W. Wien, Ann. der Physik No. 11, 1902.

* Jacobs, U. S. Patent; Ginti, Zeitschr. f. angew. Chemie, p. 1173 (1901); Haselacher, German Patent 85,021 of 1896.

† Jacobs, Journ. Soc. Chem. Ind., vol. 21, p. 391; Limb, Eng. Patent No. 7,282 (1899).

‡ Jahrbuch der Elektrochemie, vol. 1, p. 123 (1894).

§ Jahrbuch der Elektrochemie, vol. 8, p. 320 (1899); Zeitschr. f. Elektrochemie, vol. 8, pp. 61, 852 (1902); Journ. Soc. Chem. Industry, vol. 20, p. 816 (1902).

‖ Harmet, Etude sur l'Electrometallurgie du Fer, I. and II. Cf. also Electrochemist and Metallurgist, vol. 2, p. 18 (1902); Zeitschr. f. Electrochemie, vol. 8, p. 852 (1902).

* Ruthenberg, Eng. Patent 13,867, 1902; Electrochemist and Metallurgist, vol. 2, p. 12 (1902); Jahrb. der Elektrochemie, vol. 1, p. 516 (1902).

† Conley, Electrochemist and Metallurgist, vol. 2, p. 16 (1902).

‡ Bertholus, Notice sur la Fabrication des aciers au Four Electrique, Paris, 1902.

§ Benedicks, Eng. Patent No. 18,921 of 1900.

‖ Schneider, Eng. Patent No. 7,328 of 1901.

¶ Zeitschr. f. Elektrochemie, vol. 8, pp. 419-421 (1902); Volker, Eng. Patent No. 28,903 (1900).

* Kershaw, Electrician, vol. 46, pp. 164, 245, 287 (1900).

† Compiled by E. E. Fournier d'Albe in the Electrician.

A SOURCE OF INTENSE MONOCHROMATIC LIGHT.*

MANY optical experiments necessitate the employment of a source of intense monochromatic light. The flames containing a sodium salt, so frequently employed, do not always give the desired result. The intrinsic light of the flame is quite moderate, the rays are far from being absolutely monochromatic and only allow with extreme difficulty the observance of interferences to the one hundred thousandth fringe. It is true, the light may be increased by employing the oxyhydrogen flame, but it is at the expense of the fineness of the lines. And the two rays emitted, adjoining and difficult to separate, are often an embarrassment. Other salts do not have these disadvantages, but are inferior to sodium with respect to the brightness and delicacy of their lines. As to other sources sometimes employed (induction spark, electric arc containing metals, etc.), their intrinsic brilliancy is very great, but the light emitted by them does not allow of obtaining interferences with great difference of path. The metallic vapor tubes of Mr. Michelson, which give radiations remarkably simple, are unfortunately rather complicated and do not afford an intensely brilliant light.

We have obtained some excellent results by employing as a source of monochromatic light the mercury arc in vacuum, discovered and studied by M. Aronso. The electric arc flashes between two surfaces of mercury, in a closed space perfectly devoid of air. Ignition is produced by giving the apparatus a slight shake, which brings the two surfaces into contact for an instant; the arc is established and continues in the form of a whitish flame.

The special form of apparatus we make use of, was constructed by M. Chabaud, and consists of a cylindrical glass vessel, one-third full of mercury. This mercury is divided into two portions, electrically insulated from each other by a glass tube, concentric with the vessel and opening at the level of the mercury. Each of the masses of mercury is put in communication, by a platinum wire soldered in the glass with one of the poles of a source of continuous current; the central mercury with the negative pôle. As perfect a vacuum as possible is produced in the vessel. By a light shake, the two portions of mercury are brought into contact, then they separate through capillarity producing an arc.

The difference of the potential does not exceed 15 volts, but in order that the arc may be stable, the electromotive force must be at least 30 volts. A source with a more elevated potential may of course be employed, by interposing, in every case, a rheostat in the circuit. The arc continues with a current of two or three amperes; the apparatus can support a more intense current, and its luminous intensity may be raised to one carcel.

The surface of the source being small, its intrinsic light is quite elevated. The operation of the apparatus requires no watching, even for experiments of long duration.

The spectrum of this source is identical with that of the tubes of M. Michelson, with mercury vapor; passing over the lines of slight brilliancy, it includes a violet line, one green and two yellow lines, whose wave-lengths are: 43580 μ; 0.54607424 μ; 0.57695984 μ; 0.57906593 μ.

Although these lines are not as fine as those given by the mercury vapor tubes, still they allow an observation of interferences with very great differences of path. In the case of the green line, which is by far the most brilliant, the observations can extend up to the four hundred thousandth fringe (difference of path 22 cm.). The constitution of this line is the same with this source as with the tubes of Michelson.†

If it is desired to utilize the mercury arc as a source of monochromatic light, one of the rays must be isolated, green, for example. This may be accomplished by means of a prism, or more simply by the employment of absorbing media. A thin yellow glass or a thin layer of a solution of potassium bichromate absorbs the violet line, the chloride of didymium in saturated solution within a thickness of several millimeters presents an absorption band which covers the two yellow lines; a mixture of these two salts allows only the green ray to pass without enfeebling it. A weak solution of eosin only allows the passage of the two yellow rays. All these liquids may be placed in small cells, attached to the ocular of the apparatus.

Lastly, the violet ray is very convenient for photography in monochromatic light; it is useless to eliminate the yellow and green rays, since they have no action on ordinary plates, but there are several rays situated beyond the violet ray which must be got rid of. For this purpose a solution of a fluorescent liquid, such as an acid solution of quinine sulphate, may be interposed.

The light from the mercury arc in a vacuum may be employed to advantage for the determination of the number of fringes by the method of coincidences. Its light is not always sufficient for the experiments of projection; we would remark here that a still more brilliant light is obtained by causing the electric light to flash in the air, between a surface of mercury (pole +) and a carbon. We have had constructed by M. Pellin an apparatus, which is placed in an ordinary projecting lantern for the production of this arc. The rays given by this source are not so fine as those from the arc in vacuum; they enable us, however, to realize in monochromatic light and in projection the majority of the experiments of optics.

* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from the French of MM. Ch. Fabry and A. Perot in a communication to the Académie des Sciences.

† Its constitution is very complex; a thorough study by our method of inferential spectroscopy has enabled us to discover five components, distributed in the following manner: if starting with the principal component, whose luminosity is greatly predominant, we go toward the red, there is observed at distances $\frac{\lambda\lambda}{\lambda}$, reckoned from this principal component, first a line very close $\left(\frac{\lambda'\lambda}{\lambda} = 1.6 \times 10^{-6}\right)$, then a component more feeble at the distance 15×10^{-6}, then finally a very faint line at the distance 25×10^{-6}. On the violet side, at the distance 9×10^{-6}, is found another very feeble component. These lines, all much less intense than the principal components, are not generally embarrassing.

OYSTERS AND TYPHOID FEVER.

THE recent outbreaks of typhoid fever at Winchester and at Southampton have again directed public attention to the risk of typhoid infection due to the laying down of edible forms of shell-fish in sewage-polluted waters.

So long ago as 1895, in a report made by Dr. Bulstrode to the Local Government Board, it was pointed out that few of the oyster layings, fattening beds or storage ponds round the English and Welsh coasts could be regarded as free from possible sewage contamination. In consequence of this report, the Local Government Board in 1899 introduced a bill providing that the various county and borough councils should ascertain from time to time the sanitary conditions of the oyster layings and empowering these bodies to take action if sewage pollution were proved. This bill, which deals only with oysters, after having been read a second time, was withdrawn. Apparently nothing has since been done, matters have been allowed to drift, and in consequence several outbreaks of disease have occurred, with loss of valuable lives, and an important industry is threatened with temporary ruin.

In 1901, the medical officer of health for Westminster reported on certain cases of typhoid fever seemingly due to contaminated cockles, from some of which a bacillus, having all the characters of the typhoid bacillus, was isolated at the Jenner Institute of Preventive Medicine.

Dr. Nash, the medical officer of health for Southend-on-Sea, reported upon the incidence of typhoid fever in that borough during 1901, and found that in no less than twenty-one out of thirty-seven cases of the disease there was a history of the eating of shellfish (generally oysters and cockles) within a month of the onset of the disease, i. e., within the incubation period. From a report by Dr. Allan, medical officer of health for the City of Westminster, mussels also seem to be implicated.

Attacks of illness, attributed to the eating of shellfish, in the Borough of Wandsworth and the City of Westminster having been brought to the notice of the Corporation of the City of London, the last-named body has taken action. The responsibility of the City Corporation in this matter is great, for not only are the majority of the cockles and many of the oysters implicated exposed for sale in the city, but the former shell-fish is mostly obtained and relaid within the city's jurisdiction. The City Corporation has therefore caused a number of samples to be bacterioscopically examined by Dr. Klein, and his reports show that a larger or smaller proportion of the samples examined from every district shows evidence of sewage contamination, and from certain cockles the typhoid bacillus has actually been isolated.

The question then arose, as to dealing with an obviously infected and dangerous source of food supply. Under the Public Health (London) Act 1891, it is possible to obtain a justice's order to destroy such unwholesome food, but the necessary examination to establish the fact involves a lapse of several days, and before the results of such examination could be known, the whole quantity of the sample implicated would have been consumed. In the circumstances, the facts were reported to the Worshipful Company of Fishmongers, which has extensive powers over the fishing industry throughout the country, and the company's inspectors are now engaged in a survey of the various sites of the shell-fish fisheries and are taking steps to stop the sale of contaminated mollusks.

It might have been thought that sea-water would be prejudicial to the typhoid bacillus, but such does not appear to be the case. The experiments of Dr. Klein and of Prof. Boyce have shown that although the organism does not multiply, it retains its vitality in sea-water for at least three or four weeks. In the infected oyster it lives for two to three weeks or more, and even when washed in pure running sea-water, the infective properties may be retained for several days.

As regards cockles, these are "cooked" before consumption, and thorough cooking would be fatal to the typhoid bacillus. But it seems that "cooking" of cockles is a very perfunctory process, and consists in simply plunging nets filled with the mollusks into boiling water, so that many might (and obviously do) escape the full action of the heat; actual boiling renders them tough and uneatable.

Legislative enactments and periodical inspections are obviously necessary to protect the public from the risk of infection from sewage contaminated shell-fish, and should be welcomed by the merchants and their employes whose livelihood depends upon this important industry. So far back as 1894, the value of the oysters alone landed by English dredgers in that year amounted to £84,271.—R. T. Hewlett, in Nature.

AN APOTHECARIES' OATH OF THE FOURTEENTH CENTURY.

THE Journal Médical de Bruxelles for October 2, citing the Gazette de Gynécologie, refers to a case before the criminal tribunal of the Cour de Cassation, in which the point at issue was whether it was allowable for physicians and pharmacists, though practising different yet allied professions, to enter into partnership. Maitre Momard, representing the affirmative, showed that the profession of pharmacist had been from remote times a dependent of that of medicine, and in support of this view cited a curious oath of the fourteenth century which used to be taken by the "apothicaires" of those days. The oath is as follows: "I swear not to malign any of my former masters, physicians, pharmacists, or others, whoever they may be; to uphold as far as in me lies, the honor, glory, ornament and majesty of medicine; not to disclose to idiots and ingrates their secrets and mysteries; to do nothing rashly, without the counsel of physicians or in the hope of gain; to disown and to avoid like the plague the disreputable and entirely pernicious methods of practice now followed by charlatans, empirics, and dabblers in alchemy, to the great disgrace of the magistrates who tolerate them. May the Lord prosper me as I observe these conditions."—N. Y. Medical Journal.

THE NAVAL WAR-GAME WAR.—XIII.*

By FRED T. JANE.

TORPEDO ACTION OFF KEY WEST—MUTUAL DESTRUCTION.

THE tendency of torpedo craft to neutralize each other has been very marked throughout the whole war, and it has persisted to the closing stages.

For convenience, while operating on the eastern coast the Germans made a special division of their torpedo craft, which lay well outside, a dozen destroyers under convoy of the liner "Deutschland," while the heavy ships raided the coasts. On the flanks of these the American destroyers to the number of thirteen, convoyed by the armed liner "St. Louis," continually hung, but any attempt at a general action was defeated by the fact that German cruisers moved out.

All that happened therefore for some time was a series of isolated duels, usually ending in mutual destruction. By this means the Americans were reduced to seven and the Germans to six boats.

At last, however, the German fleet saw fit to return to its Havana base, which it did well out to sea, sending its destroyers more inland. The American boats had disappeared for a day or two, and the greater number were believed to be sunk; so that German wariness was relaxed. It was due to this that the American division was able to encounter the German one.

Orders were to sink the German boats regardless of cost—these boats being enough menace to keep the monitors inside Key West. Consequently the encounter from the first assumed the nature of a general massacre. The sea was somewhat rough, and, though the destroyers sought to engage each other and torpedo the big liners, what actually happened was an indiscriminate *melée* in which the "Deutschland" sank American boats and the "St. Louis" German ones. More than once friends were fired on by mistake; in the absolute jumble that ensued it was well nigh impossible to distinguish friend from foe. Both sides had discarded ensigns—these being found to attract the hostile liner too surely. There were also one or two attempts to reach the liners under false colors, which increased the confusion, for the liners, detecting the ruse, grew panicky, and fired almost indiscriminately. The only "method" in all the fight was that these two monster ships carefully avoided one another—driven to this by mutual fear of the result of an encounter. Both, it also happened, had orders not to bother about each other, but to sink destroyers.

The net result was that in twenty minutes no destroyers were left. Then, and not till then, the liners began to pay attention to each other, firing as they circled round each other at extreme range.

A few trifling upper work hits were secured, but nothing of moment occurred till the "Deutschland" got a shell in her charthouse which destroyed the wheel. At this she flew off at a tangent and made off to Havana.

The captain of the "St. Louis" was relieved of his command for not having done more; but it is difficult to see what he could have effected, since the German had the speed gage. However, the fact that he had sunk by mistake two American destroyers seeking cover near him settled the case against him; those who had not witnessed the battle refusing to believe the ease with which mistakes could be made.

As for the battle, it is extremely difficult to discuss it, because there are directly antagonistic opinions as to whether or no it simulated properly real war results. German destroyers are very unlike American ones, and have the masts in different positions. All who did not see the fight have argued that in actual fact the mistakes that marked the action could not have occurred. But in the battle correct models were employed, and the conditions were reasonable enough. All moves were made by time—in 30-second moves. In those 30 seconds each player had to move his boat to time and indicate the craft he fired at—a good deal to do in one half-minute. He also had to keep a sharp lookout for disabled boats drifting about, and to be wary of the attacking liner. Consequently every boat coming toward was apt to be taken as a foe, every boat moving in the same direction as a friend. A slightly disabled German boat noting this, turned and accompanied the Americans, with a brilliant notion of thus sinking several of them. Instead, she was sunk by her own friends. There was no time, sometimes no opportunity, to note the funnels or mast of the advancing model. To do so probably entailed loss of fire, and loss of fire was a fatal error.

On the whole, few of those who participated grumbled much at the conditions laid down, and most agreed that they made no unfair simulation of real war as understood and anticipated by them.

As remarked above, it is hard to say conclusively that the results were real or unreal. If real, then the irresistible conclusion is that torpedo craft will have value in the next war only for destroying each other, and after one side has lost all its boats—that at the most they cannot be assigned a higher value than the pawn has in chess, without the pawn's ability to become a king. Now the value of a pawn outside that is not very great with players of equal ability, as they can be set off against each other, and always there is considerable increase of value only when all the pawns of one side are taken or completely neutralized. Otherwise their value is of a defensive nature chiefly, and the defensive is ever the side that loses in the long run.

A noteworthy incident of these operations was the high value exhibited by the big liners as destroyer-destroyers. The idea of this use seems to have been well grasped by both sides, and so little respect was there for the orthodox rôle of "armed cruisers" that the first claim made by both sides was to take out most of the 6-inch and 5-inch guns from these craft and substitute enormous batteries of anti-torpedo craft guns—14-pounders and the like.

The above battle was a distinct advantage to the

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.

THE GERMAN BATTLESHIP "H," NOW BUILDING, AND THE TORPEDO-BOAT "S 126."

Americans. Their remaining torpedo craft were not immediately available, but free from the German torpedo menace the monitors were now able to put to sea without fear of being torpedoed.

With the "Iowa" and "Texas" the monitor fleet, directly moderate weather was recorded, went off Havana, offering battle—a gage that the Germans cheerfully accepted. For America, the salvation of the east coast depended on crippling the Germans; for Germany, with the prospect of having to fight the two "Maines," now near the Horn, it was altogether desirable to destroy the monitor fleet that else would intercept them on returning after battle to Havana. Moreover, there was a very strong risk of the recapture of Havana, once the German fleet went away to battle elsewhere.

And so began the most curious battle of the war, on one side orthodox battleships and cruisers, fast and fairly well supplied with heavy and R. F. guns, on the other a heterogeneous collection of monitors of varying date, the old ram "Katahdin," and some submarines—a fleet very nearly devoid of quick-firers, slow and unwieldy, but hard to hit and with a preponderance of big guns. And to add to the strangeness, each side was firmly convinced that it would secure an easy victory.

(To be continued.)

SOME NEW TYPES IN THE GERMAN NAVY.

For the last forty years a steady increase in the size and efficiency of guns has produced a corresponding accumulation upon men of war of defensive armor plate, which, on its part, greatly improved in its protecting value as time went on. Both these changes tended to increase the weight and therefore the size of the ships, and a gradual growth of the displacement of battleships and cruisers is noticeable in the navies of all countries. A similar effect has been produced in the merchant service, by the demand for quick transport and long-distance traffic, the former necessitating considerable engine space and additional storage room for fuel, while the latter makes at any rate the second of these conditions necessary.

This increase is very clearly shown in the torpedo boats of the German fleet, whose displacement has risen from 85 to 350 tons within the last twenty years. The internal equipment, too, of the ships has undergone very marked changes, not only in the introduction of the use of electricity for a number of auxiliary machines and for other purposes, but also in the disposition of the guns and the mechanism for discharging torpedoes. The latter has been placed below the water line in the most recently launched German battleships H, I, K, L. Our illustration gives a view of a number of ships of this type, showing more particularly the battleship H and the torpedo boat G 108, the latter being the fastest ship in the German navy.

The battleship H now building in the dry docks at Kiel has a length of 398 feet 6 inches, and a beam of 72 feet 10 inches, with a calculated draft of 25 feet and a displacement of 13,200 tons when fully equipped. It is by 2,050 tons larger than the boats of the "Kaiser" class, of which one is shown on the left in our illustration. The three propellers are driven by three triple-expansion engines, which have a combined horse power of 16,000, producing a speed of 18 knots per hour. The requisite steam is raised in six cylindrical boilers and eight water-tube boilers of the Schulz type. The normal cargo of coal is 700 tons, the maximum cargo 900 tons, and 200 tons of oil fuel can be carried in addition.

The armament of these ships is unusually heavy. It consists of:

(1) Four 11-inch quick-firing guns of 40 calibers, mounted in revolving turrets.

(2) Ten 6¾-inch guns of 40 calibers in the battery.

(3) Four similar guns in revolving turrets.

(4) Twelve 3½-inch guns of 35 calibers length on central pivot carriages (pattern 1889).

(5) Twelve 1½-inch machine guns and eight 1-3-inch machine guns.

The heavy 11-inch guns stand in pairs in two armored turrets in front of the foremast and behind the mainmast respectively. The battery with ten 6¾-inch guns lies between the two turrets, but on the next lower deck and above the battery on the upper deck are placed the four smaller revolving turrets for the remaining four 6¾-inch guns.

The foremost and rearmost battery guns can also be fired dead ahead or dead astern. In the arrangement of smaller guns (3½ and 1½ inch) the chief object kept in view was to give them as large and as open a field as possible. The new ship H is capable of concentrating two 11-inch guns, four 6¾-inch guns, and six 3½-inch guns fore and aft, or four 11-inch guns, seven 6¾-inch guns and six 3½-inch guns on either broadside.

The armor plating, too, shows many improvements in the ships of the H class. The barbette and citadel armor is so combined with the barbettes of the heavy revolving turrets that there is no unprotected portion left between them. The central armor is reinforced and the conning tower and the barbettes of the revolving turrets have more than the usual protection. The water-line belt extends the full length of the ship, and the citadel armor over three-fifths of the length. There are also two horizontal, slightly convex armored decks, of which the lower one is at the level of the lower limit of the belt armor, the upper one being above the water-line. The torpedo equipment in these battleships of the class H, just as in those of the "Kaiser" class and of the "Wittelsbach" class, consists of six torpedo tubes for 17¾-inch torpedoes.

The excellence of the new torpedo boats built in the "Germania" docks is well known. At their trial runs they made about 29 knots per hour, carrying their full equipment. Four of these have been built so far, two more being now building. These fast boats are 206 feet 8 inches long, have 23 feet beam, and 350 tons displacement. The two propellers are driven by engines indicating 5,400 horse power, and according to contract 26 or 27 knots per hour were to be attained. As stated above, the speed actually produced exceeded this. The armament consists of three 2-inch quick-firing guns, of which two are placed on either broadside in front of the conning tower, and the third is astern on the after conning tower. The torpedo equipment consists of three tubes of 17¾ inches diameter.

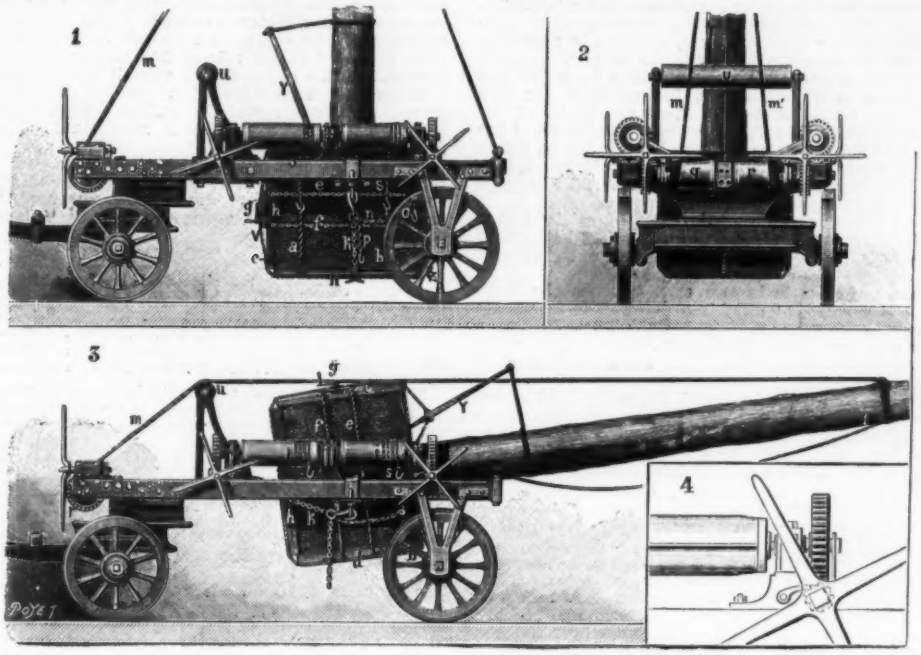
A NEW WAY OF MOVING TREES.

For the purpose of quickly stocking gardens, in order that a dense shade may be obtained as soon as possible, it was formerly the custom to effect the transplanting of large trees, with their adhering clods of earth, by the most diverse methods; but for less than half a century past, this operation has been performed with greater ease by means of special vehicles, the present type of which, constructed by M. Seignant, was adopted by the Paris service of public promenades and gardens at the time of its organization. It is to this service, organized by M. Alphand in 1855, that is due that innovation which, since the transformation of the Bois de Boulogne, has made possible the formation by means of choice and beautiful specimens of the groves and isolated clusters of trees that are the admiration of everybody.

As may well be imagined, this new method soon came to be imitated and put to profit, not only in the special service of the large cities of France and Europe generally, as well as in America, but also on large private estates. But although for a long time the type of transplanting vehicle such as was devised and constructed at the outset, with a few slight modifications, subsequently introduced, fully sufficed, and still answered well enough in many cases, certain improvements have, during the last fifteen years, become necessary. This old type of truck made it necessary to carry trees from 20 to 25 feet or more in height, in a vertical position; or to employ quite a large force of laborers if the trees had to be inclined in order to avoid obstacles, such as bridges, telephone and telegraph wires, etc. When, from various reasons, it was impossible to incline the trees sufficiently, it was necessary either to make troublesome detours in order to avoid such obstacles, or, after lengthy and tiresome formalities, to obtain a permit to cut the wires, and afterward have them immediately repaired by employes of the company to which they belonged. This all involved considerable expense.

It therefore became necessary to introduce into the type of truck, used up to the present, improvements that would make it possible to carry trees of large dimensions either in a vertical or an inclined position, at the will of the operator, and according to requirements, without the necessity of employing a large force of men to perform the operation on the route. It was necessary, on the other hand, that in such operations the clod of earth should be left intact, since the latter is indispensable for the re-rooting of the tree.

The new type of truck, exhibited by M. Beusnier at the last Horticultural Exposition at Paris fully answers such requirements. An ingenious arrangement of windlass and ropes permits, when it is desired, of inclining the tree toward the rear of the truck until it reaches a horizontal position, and of holding it in that or any other position desired; while a combination of chains supports the clod of earth in its rotary motion. The operation can be performed by one man, while six men are required with the old type of truck. This is therefore recommendable, as far as its operation is concerned; but, in order to be exact, we must add that the pieces of its complicated mechanism make it very heavy, and considerably increase its cost. This limits the use of it to the transplanting of trees whose removal is difficult on account of obstructions on the roads that have to be traversed.

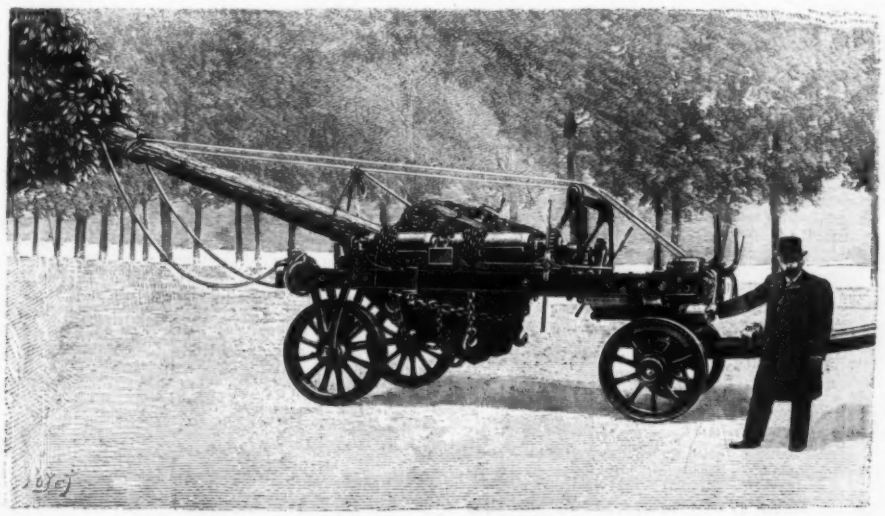


VEHICLE FOR TRANSPLANTING TREES.

1. Tree loaded in a vertical position. 2. Front view. 3. Operation of lowering the tree to a horizontal position. 4. Details of the mechanism of the windlass.

The apparatus is used as follows: The clod of earth having been prepared and surrounded by suitable protective wicker-work, and the truck having been placed upon planks, laid beside the tree trunk, two planks *h* (Fig. 1) are shoved under the roots. Beneath these planks are drawn the two bottom chains, *a*, *b*, which are hooked on each side to those of the four windlasses, *i j*. Five planks, *c*, *d*, are afterward placed, two in front and three in the rear of the clod, and held by chains, *e f*, that are connected by the rack-jack, *g*, placed in front for tightening up the whole.

The tree is then raised, by actuating the windlass,



VEHICLE FOR TRANSPLANTING TREES.

to the height necessary to permit of hooking the central chain, *k*, to the ring, *l*, fixed to the frame of the truck. The semi-circular chain, *u*, is hooked to the rear of the clod, and, since it is heavy, is supported at *o* by two small chains suspended from the frame, *e*, of the vehicle.

The wicker-work around the clod being complete and being reinforced by a few roots beneath, the chains *k*, *v*, *x* are put in place and afterward hooked under it, and it is lowered until it rests upon *k*, which should be as nearly in the axis of the tree as possible. The rôle of the chains *v* and *x*, which are connected with the lever *y* above, is to hold the wicker-work and

prevent the slipping of the chain *k*, when the tree is inclined; and also to keep the latter in position.

The operation necessary to incline the tree is afterward performed quite simply. The ropes *m* and *m'* (Fig. 2), passing over a roller when the tree is lowered or being brought back to a vertical position, wind around the windlasses *q* and *r* and hold the trunk firmly in place. The bottom chain *b* (Fig. 3) is removed, and the tree, resting completely upon the chain *k*, loses its equilibrium when the windlasses *JI*, on the side of the truck, on which is wound the chain, *s*, are moved, and thus it is caused to assume the inclination desired by turning the windlasses *q* and *r*, which wind up the supporting ropes *m* and *m'* (Fig. 3).

If the tree were insufficiently inclined, and therefore touched the rear crosspiece, it would be necessary to couple the chains of the forward side windlasses, *JI*, with those of the bottom, *b*, and then hook the two stop-chains, *p c* (which are indispensable for this operation) to the first link, *S*, of the hooks of the windlass. Then, in order to prevent the sliding of the chain which supports the planks, *c d*, the tree is raised by means of the windlasses, *JI*, to a sufficient height to incline it as much as may be desired and disengage it from the rear crosspiece.

By gradually unwinding the ropes *m m'* by means of the two front windlasses, the tree may be brought to a front horizontal position and held thus while it is being moved.

When the obstacle is overcome, or when the destination is reached, all that is to be done is to actuate the windlasses *q* and *r* (Fig. 2) in order to bring the trunk to a vertical position. Fig. 4 gives the details of one of the windlasses with which the truck is equipped.

As may readily be imagined, these different operations are performed in less time than it takes to describe them, and the truck is a decided improvement upon the old type used heretofore.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

PRODUCTION OF ARTIFICIAL STONE OF VARIOUS KINDS.

THE production of artificial stone of various kinds has assumed a great deal of importance by reason of the facts that the productions are adapted to molding and coloring, that they are not affected by frost, and that there is a resisting power that can be depended on.

The following is a process of manufacture in which the alkaline silicates prepared industrially are employed.

The function of the alkaline silicates, or soluble glass, as constituents of artificial stone, is to act as a cement, forming with the alkaline earths alumina and oxide of lead, insoluble silicates, which weld together the materials (quartz sand, pebbles, granite, fluorspar and the waste of clay bricks). The mass may be colored black by the addition of a quantity of charcoal or graphite to the extent of 10 per cent at the maximum, binoxide of manganese, or ocher; red, by 6 per cent of colcothar; brick red, by 4 to 7 per cent of cinnabar; orange, by 6 to 8 per cent of red lead; yellow, by 6 per cent of yellow ocher or 5 per cent of chrome yellow; green, by 8 per cent of chrome green; blue, by 6 to 10 per cent of Neuwied blue, Bremen blue, Cassel blue, or Napoleon blue; and white, by 20 per cent, at the maximum, of zinc white.

Chrome green and zinc oxide produce an imitation of malachite. An imitation of lapis lazuli is obtained by the simultaneous employment of Cassel blue and pyrites in grains. The metallic oxides yield the corresponding silicates, and zinc oxide, mixed with cleansed chalk, yields a brilliant marble. The ingredients are mixed in a kind of mechanical kneading trough, furnished with stirrers, in variable proportions, according to the percentage of the solution of alkaline silicate. The whole is afterward molded or compressed by the ordinary processes.

The imitation of granite is obtained by mixing lime, 100 parts; sodium silicate (42 deg. Bé.), 35 parts; fine quartz sand, 120 to 180 parts; and coarse sand, 180 to 250 parts.

Artificial basalt may be prepared by adding potassium sulphite and lead acetate, or equal parts of antimony ore and iron filings.

To obtain artificial marble, 100 pounds of marble dust or levigated chalk are mixed with 20 parts of ground glass and 8 parts of fine lime and sodium silicate. The coloring matter is mixed in proportion depending on the effect to be produced.

A fine product for molding is obtained by mixing alkaline silicate 100 parts, washed chalk 100 parts, slaked lime 40 parts, quick lime 40 parts, fine quartz sand 200 parts, pounded glass 80 parts, infusorial earths 80 parts, fluorspar 150 parts. On hardening there is much contraction.

Other kinds of artificial stone are prepared by mixing hydraulic lime or cement 50 parts, sand 200 parts, sodium silicate in dry powder 50 parts; the whole is moistened with 10 per cent of water and molded.

A hydraulic mortar may be employed, to which an alkaline silicate is added. The stone or object molded ought to be covered with a layer of fluosilicate.—Translated from La Revue des Produits Chimiques for the SCIENTIFIC AMERICAN SUPPLEMENT.

DEVELOPMENT AND PROPAGATION OF THE EXPLOSIVE WAVE.*

IN the course of the researches of M. Berthelot and myself on the detonation of acetylene, we had occasion to observe that the photographic method is applicable to the study of the explosive wave. At the suggestion of M. Berthelot, I have applied this method to the study of the peculiarities presented by the development and propagation of this wave. My experiments have been conducted with mixtures of acetylene, with oxygen and the oxygenized compounds of nitrogen, and with the detonating mixture of carbon oxide with oxygen.

Development of the Explosive Wave.—When mixtures of acetylene and oxygen are ignited by an electric spark, the immediate velocity of propagation of the flame is several hundred meters per second, and this velocity is rapidly accelerated until it exceeds a thousand meters per second. Then the explosive wave, characterized by a velocity still greater and strictly uniform, starts into being. The initial phenomenon is quite different from that observed with mixtures of hydrogen and carbon sulphide, in which the velocity at first does not exceed thirty meters. On replacing the oxygen in the mixture of acetylene with nitrogen protoxide or bioxide, the general rate is not materially modified. In the case of mixtures of carbon oxide and oxygen, ignition by the spark gives very slow initial velocities, a few meters per second only, too slow to be registered by apparatus in which the photographic plate is moved at the rate of 8.50 meters per second. By igniting this mixture with a small charge of chlorated powder, a velocity of a thousand meters per second is obtained; still the explosive wave does not come. The limited velocity is maintained at about 1,300 meters per second.

In the case of mixtures of acetylene inclosed in a tube 10 millimeters in diameter, and ignited by an electric spark, the explosive wave commenced spontaneously after the following courses of the flame:

$2\,C^2H^2+O^2$	1 m.
$C^2H^2+O^2$	0.05 m.
$C^2H^2+6O^2$	0.15 m.
$C^2H^2+10O^2$	0 80 m.
$C^2H^2+2\,AzO$	0.20 m.
$C^2H^2+6\,AzO$	0 50 m.
$C^2H^2+2\,Az^2O$	1.00 m.
$C^2H^2+6\,Az^2O$	0.10 m.

There is, in no case, continuity between the variable period and the explosive wave. The wave arises at a certain distance forward of the flame of variable velocity—at 0.05 m. in the mixture of $C^2H^2+O^2$. This is shown by a sudden change in the registered photographic curve. The prolongation of the straight line corresponding to the wave cuts the curved line corresponding to the variable velocity a little before its extremity. In this variable period the flame is preceded by a compressed wave, which passes on before it with equal velocity, like the undulations preceding the prow of a vessel. When the explosive wave is developed, the two phenomena are superposed; that is, the forward part of the compressed wave coincides with the gaseous section in combustion, instead of preceding it.

At the point where the explosive wave commences, the gaseous mass immediately becomes obscure and loses all photogenic action, in consequence of the rapid cooling. The dark mass moves afterward from right to left in the tube under the influence of the vibratory movements. In the ulterior course of the explosive wave the same cooling does not occur, because each gaseous section, before burning, has received from the preceding section an amount of energy equal to that which it imparts to the following. The first section alone is in a different condition.

Velocity of the Explosive Wave.—The same experiments have allowed the measuring of the velocity of the explosive wave in a path of one meter only. Below are some of the results. They cannot have the same precision as those secured by Messrs. Berthelot and Vieille with tubes of a great number of meters in length.

$2\,C^2H^2+O^2$	2160 m.
$1.5\,C^2H^2+O^2$	2510 m.
$C^2H^2+O^2$	2020 m.
$C^2H^2+3\,O^2$	2220 m.
$C^2H^2+4\,O^2$	2190 m.
$C^2H^2+6\,O^2$	1950 m.
$C^2H^2+10O^2$	1850 m.
$C^2H^2+2\,Az^2O$	2580 m.
$C^2H^2+6\,Az^2O$	2400 m.
$C^2H^2+2\,AzO$	2850 m.
$C^2H^2+6\,Az^2O$	2800 m.
$CO+O$	1900 m.

Limited Mixtures.—The explosive wave cannot propagate itself in all combustible mixtures. It is interesting to note what passes in mixtures at the limit of propagation as with the three following, among those studied, as given above: $C^2H^2+10O^2$, $C^2H^2+6\,AzO$; $CO+O$. In the first two of these, the explosive wave is extinguished from time to time—at the passage of the elbows, for instance, or of the contracted parts—and is replaced by a propagation of variable velocity, notably higher; then this is accelerated again and ends by renewing the explosive wave.

In the case of carbon oxide and oxygen, the phenomena are still more interesting. The explosive wave does not arise spontaneously; consequently it is not renewed when once extinguished. It can be excited by means of a charge of fulminate of 0.05 gramme, but if the charge is too strong—for instance, 0.75 gramme—it is not obtained. The compressed wave by this charge is too rapid and cannot be followed by the explosive wave of the gaseous mixture, which remains behind and is extinguished in consequence of the agitation of the gaseous mass.

These are the results obtained:

Nature of Charge.	Mode of Propagation.	Average Velocity.
0.10 gramme Chlorated Powder.	Variable.	1280 m.
0.05 gramme Fulminate	Explosive Wave.	1900 m.
0.75 gramme Fulminate	Undulatory.	1210 m.

(SECOND PAPER.)

PROPAGATION OF CONDENSED WAVES IN HEATED GASES.

THE propagation of gases near the ordinary temperature was studied very thoroughly by M. Vieille. His experiments gave for the velocity of these waves, conformably to the theory of Hugoniot, values quite superior to the velocity of sound, which is that of waves immeasurably less condensed.

The photographic method has enabled me to study different peculiarities of these waves in the case of heated gases obtained by the combustion of explosive mixtures. The propagation of the waves is manifested in the phenomena capable of being registered; in the case of those quite condensed by an increase of luminosity due to the heating resulting from the adiabatic compression; in the case of weaker condensations by a change in the velocity of movements within the gaseous mass. These movements are observable by reason of the accidental diffusion of light from one point to another of the products of combustion, especially where carbonaceous particles remain in suspension, as occurs with mixtures of acetylene containing an excess of this gas.

Discontinuity.—According to the theory, every condensed wave should be the seat of a discontinuity of the gaseous mass. Their propagation is a phenomenon analogous to the eddying of water. On all sides of the wave the medium experiences a sudden change of state. This wave cannot, however, be compared with a geometrical surface infinitely limited, because, carrying with it a finite amount of energy, it must affect a finite quantity of matter. My experiments show that the thickness of the wave, that is, the zone of variable state, is in every case very small. For waves slightly condensed, the thickness falls below the uncertainty resulting from the diameter of the glass tubes employed, which was 5 mm. It can be affirmed that it falls below 1 cm., and that it does not take a hundred thousandth part of a second to cause a given point of the gaseous mass to pass from one of its extreme states to the opposite state. For waves quite condensed, which notably increase the luminosity of the gas on their passage, the thickness would seem to reach 1 cm.; but the enlargement of the photographic image, which still does not reach 0.5 mm., may be due to the irradiation of the sensitive plate.

It must, then, be concluded that if the discontinuity cannot be absolute, in the mathematical sense of the word, the zone of variable state is yet sufficiently thin to escape very precise processes of investigation. Everything seems to pass as though the discontinuity is absolute.

Production of Condensed Waves.—The development of condensed waves is produced spontaneously in mixtures of great velocity of propagation, principally in the following conditions:

1. At the moment of spontaneous development of the explosive wave, a retrograde condensed wave is propelled backward in the burned gases.

2. The complete or partial arrest of the explosive wave against the closed extremity, or in the contracted portion of a tube, throws backward a reflex condensed wave.

3. At the point of meeting of explosive waves ignited simultaneously in different parts of a gaseous mixture, their simultaneous extinction gives rise to *prolonged* condensed waves, which proceed in the same direction as the explosive waves which they succeed.

Condensed waves can be excited artificially by means of mercury fulminate placed in advance of the middle of the gaseous mass, so that its detonation takes place at the moment when reached by the flame.

Velocity of Condensed Waves.—This velocity is quite variable, depending on the extent of condensation and density of the gaseous mass affecting their formation and temperature. It approximates more and more to the normal velocity of sound, as the condensation decreases. A definite value is therefore not to be sought for this velocity. These are some figures obtained with the combustible mixture $C^2H^2+O^2$, of which the ignition was caused by an electric spark. The length of the tubes was 1 m. and their diameter 5 mm.

Explosive wave	2990 m.
Retrograde wave	2300 m.
Reflex wave	2250 m.
Prolonged wave	2050 m.
Wave with 0.1 gramme fulminate	2250 m.
Wave with 0.75 gramme fulminate	2600 m.

The last velocity approximates that of the explosive wave without, however, reaching it.

Following are some similar results with other gaseous mixtures:

Composition of Mixture.	Nature of Wave.	Velocity.
$CO+O$	Explosive wave.	1900 m.
	Reflex wave	1000 m.
	Wave with 0.1 gramme fulminate.	1250 m.
$C^2H^2+2\,AzO$	Explosive wave.	2850 m.
	Retrograde wave.	1140 m.
	Reflex wave.	1350 m.

Intersection of the Waves.—These different waves are in their turn reflected from the extremities of the tubes and finally intersect each other. Contrary to what happens with slightly condensed waves, which cross each other without reciprocal influence, these more highly condensed waves, on meeting, experience sudden diminutions of velocity. The loss of velocity is still greater after the reflections at the closed extremities of the tubes. For example, a retrograde wave in the mixture $C^2H^2+O^2$ presented the following:

Initial velocity	2300 m.
After reflecting	1350 m.
After a first intersection	1080 m.
After a second intersection	980 m.

In the same mixture the velocity of the wave produced by 0.1 gramme of fulminate fell, after intersection with the preceding wave, from 2250 m. to 1900 m.

Undulatory Movements.—Independently of these isolated waves, the gaseous mass, after their passage, remains animated with undulatory movements analogous to the vibratory movements of sound, in which there is a transference of matter, while in the waves in question there is only a transference of a certain state of the matter through the gaseous mass. The velocity of these displacements changes suddenly after the passage of each wave. Some figures will give an idea of the extent of these velocities and their variations.

The same portion of the mass presented successively velocities of + 177 m., — 200 m. and 150 m. In the same mixture, another portion presented successive velocities of — 340 m. and + 296 m., the variations occurring suddenly on the passage of the wave, in a time less than one hundred thousandth part of a second, which implies enormous differences of pressure

*Translation of a paper of H. Le Chatelier, presented to the French Academy of Sciences.

on all sides of the very thin section affected simultaneously by the wave.

[NOTE.—M. Vieille, whose knowledge of explosives has been utilized by the government, and who is now Director of the Central Laboratory of Powders and Saltpeter on the Quai Henri IV. at Paris, received his chemical training, like many other distinguished chemists, in the laboratory of Prof. Berthelot, and afterward became famous from his intimate association with Berthelot in his researches. The veteran master, who is now a Senator, has also often been called into the service of the War and Navy departments, being placed at the head of commissions for the examination of new substances and appliances.—ED.]

TRENTON ROCK PETROLEUM.

By W. S. BLATCHLEY and W. H. SHEAK.

PROF. W. S. BLATCHLEY, the State Geologist of Indiana, has made a thorough study of the oil-producing rocks of this commonwealth. As the same conditions prevail in all other petroleum fields where the oil has its source in the Trenton limestone, the facts obtained become of general interest. The results are summarized in the following paragraphs.

The Trenton limestone, which underlies the whole of the State of Indiana, is the source of by far the greater part of the gas and oil produced within our borders. The Trenton is one of the lower or older formations of the Lower Silurian system. The upper formation of this system, namely the Hudson River limestones and shales, constitutes the surface rocks of several counties in the southeastern part of the State. Between the Hudson River limestone and the Trenton limestone is a persistent, fine-grained dark brown or blackish shale, known at the Utica shale. This lies immediately on top of the Trenton limestone and forms the necessary impervious cover over the porous portions of the latter. In these porous portions the oil and gas are stored, and the presence of the over-lying close-grained Utica shale has for centuries kept these stored products from escaping upward and passing off as volatile substances. The Trenton does not outcrop or form the surface in any part of the State, and its known closest proximity to the surface is near Lawrenceburg, Dearborn County, in the extreme southeastern portion, where it is 348 feet below the surface of the ground.

The Trenton limestone is a sedimentary rock; that is, one which was laid down in water—the bottom of the sea—ages ago. When first formed it was a nearly pure calcium carbonate or carbonate of lime. In the course of time, however, certain areas of the sea bottom, covered with the incipient limestone, were slowly raised until they became higher than the others, thus forming shallow basins, bays, or lagoons. Some of these raised portions covered large areas. Others were separated from the main area, sometimes by a distance of twenty or thirty miles. The outline of all was irregular, with many indentations. In these more shallow portions of the Silurian seas the water became in time very briny and caused a chemical change in the rock. To the lime carbonate was added some magnesia from the brine, and a magnesia-lime carbonate called "dolomite" resulted. Wherever this change took place, which was only in the shallow, briny areas, the resulting *dolomite* was porous. This condition was due to the fact that the new crystals of dolomite were smaller than the old crystals of lime carbonate and could not entirely fill the spaces occupied by them. But the larger areas of Trenton beneath the bounds of Indiana, were either too impure to admit of this change or the conditions of sea level were never such that it could take place; hence they are non-porous and barren of both oil and gas.

The petroleum of the Trenton limestone was formed in that rock many thousands of years ago. Myriads of animals, as polyps, bryozoäns, crinoids, brachipods, trilobites, and fishes lived in the sea at the time the Trenton was being deposited. The presence of such swarms of animal life indicates a profusion of plants, since the plant must ever precede the animal and gather for it the food necessary to its existence. These plants were mostly marine algæ, or seaweeds and fucoids, though doubtless many other forms flourished, of which no remains have been preserved in the rocks of that age. As these organisms, both plant and animal, died, their bodies, in vast numbers, were buried in the slowly forming sediment. By the waters above and the ooze around them they were shut off from the free oxygen of the atmosphere, and the decay ordinarily undergone by dead organisms was thereby prevented. Instead of decaying, their soft parts underwent a *process of slow destructive distillation*, which resulted in the petroleum now being brought up from the rocky depths. The crusts and shells of their bodies went far toward forming the carbonate of lime of the Trenton rock, fully 80 per cent of which is derived from their secretions and incrustations. It is a well known fact that if wood, coal, or the body of any animal be placed in an air-tight retort and heated, a distillation will occur, and the object will be changed to gaseous, oily, and solid matters. In the absence of heat and air a very long period of time will bring about the same results. This is what is meant by a *process of slow destructive distillation*.

The surface of the Trenton limestone is not level, as many people suppose, but, like the surface of the earth, is a series of alternating arches and depressions or ridges and valleys. Wherever gas and oil occur they will be found in a porous stratum in one of the arches, or *anticlines*, as they are called. If a bore is put down and happens to strike a depression, or *syncline*, salt water will invariably be found. If both gas and oil are found in a certain area, and the bore strikes the flank or side of an arch, oil will result. If the bore strikes the crest or dome of the arch, gas will flow. The cause of this is simple, being due to the arrangement of the three fluids according to their relative weights. When the oil was first formed it was pushed or carried hither and thither by the heavier salt water. Much of it was carried away by the salt water and lost, but whenever one of the porous areas existed in the side or top of an anticline the oil was carried into it and there remained. During the ages which have elapsed much of the oil was changed into a volatile gas, which rose into the higher porous portions. As this gas accumulated, it pressed back the remaining oil into the sides or flanks of the arch. The oil being lighter than the water, rested upon the latter and kept it from rising to the higher portions. When a bore is put down and strikes gas, the gas will flow till the quantity stored in the porous area of the anticline is exhausted, when the oil, if any be present on the sides of the porous stratum, will rise in the gas well. It may be that the oil has been carried by the salt water into another anticline, and that only salt water occurs beneath the gas. If this be true, the water will fill the gas well so soon as the pressure has been sufficiently reduced. The gas in one anticline is often shut off from that in a neighboring anticline by intervening oil or water, or both. In the same way the oil in an anticline that contains oil only, may be shut off from that in another anticline by the salt water filling all the porous portions of the syncline between.

A fallacy held by many oil operators in Indiana, is that oil fields or "pools" run in lines and that one field is connected with all others, the oil flowing from one to the other, through a continuous strip of porous rock. This may in part be true in the Pennsylvania oil regions, but it is wholly untrue in the Trenton limestone area of Ohio and Indiana. While all the pools of this area are found in the anticlines of the Trenton formation, they are not necessarily connected, nor do the anticlines run in straight lines. A pool may be of any shape and may lie in any direction from any other pool. Its boundaries may be straight or sinuous; more probably the latter, however. Its area may be one square yard or one thousand square miles. If the conditions necessary for the storing of petroleum, namely, a porous reservoir, located in the flank or dome of an anticline of the Trenton limestone, with an impervious cover above it and a water pressure below, have been present, the oil will very likely be found, whatever the shape, size, or relative location as to other similar reservoirs. If, however, any one of these conditions is lacking, or has been lacking, the bore is sure to be a dry hole. Inasmuch as the top of the Trenton limestone in the main Indiana field is anywhere from 700 to 1,000 feet below the surface, it will be seen that the problem of locating in advance a paying well, is a most difficult one.

Samples of oil, or of water containing oil, are constantly being received at the office of the State Geologist, from stations outside the present producing oil field. For the most part they have been gathered near the surface, and the persons collecting them believe that they are "surface indications" of the presence of petroleum in paying quantities. In this they are mistaken, for the sample collected, if traced to its source, will be found to have exuded from a crevice in some neighboring stratum of rock, or to have come from some large mass of vegetable matter, partially or wholly covered with water or mud. Every shale, sandstone, or limestone in the State contains oil in greater or less quantities, and even where the amount is infinitesimally small, enough may collect to exude from a crevice and produce a showing upon some near-by surface of water. In the minutely diffused state in which the oil is originally formed, it is wholly without value; it must be concentrated into reservoirs before it can be utilized by man.

There is absolutely no such thing as a "surface indication" of gas or oil. Where they occur in paying quantities in this State, they are found at depths varying from 700 to 1,500 feet below the surface, and no man can say with certainty that a bore put down, even in the best prospective territory, will yield either in paying quantities. The operator who is thinking of putting down a bore in undeveloped territory, can only sink his drill; he has no way of knowing beforehand what the result will be. He may pierce the center of a reservoir and get a 500-barrel well; he may strike near its outer rim and get a 10-barrel well; he may miss it altogether and get a dry hole. If he strikes a productive well, however, there is one thing he can rely upon; that is, that he is drawing upon a stored product which is not now being formed in the rock from which it is drawn, and that, therefore, he must eventually exhaust the stock from the immediate vicinity of his bore.

Where a bore for petroleum has resulted in a good producing well, the level of the surface of the Trenton rock below tide should be carefully ascertained. This can be done only by running a transit level from the nearest point where the surface level is known, usually on a railway, to the surface of the bore. The location of the first dozen or more wells in any area a mile or two square, must of necessity be largely a matter of guesswork; but if the surface level of the Trenton in each bore, productive or dry, be carefully ascertained, the trend of the anticline and the approximate limits of the field or pool can be determined. Too much guesswork concerning the surface levels has been done in the past. In a broken country it is difficult for any man to guess, even approximately, the relative levels of two points a quarter of a mile apart, and the new level should always be ascertained with instruments. Of course the surface level of the bore has nothing to do with the absolute height or surface level of the Trenton, or the absence or presence of petroleum, but it has a great deal to do with the *accurate determination* of the surface level of the Trenton, and therefore with the location of future wells. If a few thousand dollars had been spent in past days in the careful determination of surface levels in Indiana, a few hundred thousand which have been sunk in dry holes would have been saved.

Gallois finds that the application of hydrogen peroxide solution is a ready means of removing superfluous hair. A piece of absorbent wool moistened with the solution is applied to the region to be epilated for a few minutes daily. In a few days the hairs become bleached and finally appear as an almost imperceptible down. If the treatment be continued, they ultimately break off near the roots, and so disappear. It is then only necessary to renew the application from time to time. The method appears to possess advantages over the ordinary means employed against hypertrichosis, such as epilation by means of instruments, electrolysis, and caustic depilatories.—Druggists' Circular and Chemical Gazette.

THE OLDEST OF ALL LAW BOOKS.

PRESIDENT HUGO WINCKLER, of the University of Berlin, has just published a translation of Hammurabi, taken from a stele discovered a few months ago by the French expedition that has been for years engaged in archæological researches in Susa, the ancient capital of Persia, under the direction of Prof. De Morgan. Prof. Winckler gives it as his opinion that the inscription is doubtless the most important find that has ever been made in Babylonian literature. The inscription was found on a block 2.25 meters in height, taken from the old royal castle in Susa.

According to the New York Sun, this stele contains, besides a picture illustrating how King Hammurabi received these laws from the sun god, a complete legal code of 282 separate laws, of which, however, Nos. 66 to 99 have been chiseled out. This gap is in part remedied by fragments found in the great library of Assurbanipal.

There are sixteen columns of inscription found on the front of the stone beneath the picture of Hammurabi, and twenty-eight on the rear.

A special introduction and concluding admonition to future generations to observe faithfully the requirements of this code indicate that the laws contained in it were made by Hammurabi, the contemporary of Abraham, the Amraphal of the Scriptures, and that this is the oldest *corpus juris* extant, antedating even the days of Moses by half a thousand years and more, the date of Hammurabi being about 2300 B. C.

That a Babylonian inscription of this sort should be found in the Persian capital is readily explained by the fact that it was brought to Susa as booty by the Elamite kings, and it is not the only specimen of the kind here found, the transfer being made probably in the seventeenth or sixteenth century. The discovery only confirms what was indicated by the Tel-el-Amarna finds in Egypt dating from the fourteenth century, which are also in cuneiform writing, namely, that this was at that early period the common language of diplomacy and international and business communication.

An analysis of these laws shows that the code was confined to secular matters; and while in many instances it forces upon the reader, both by its agreements and its disagreements, a comparison with the legal system of the Pentateuch, it is sharply distinguished from this by the absence of religious or ceremonial commands and prohibitions.

It is exclusively a civic code. In general it shows its Semitic origin by recognizing, even to a greater extent than is done by the Pentateuch, the *lex talionis* of an eye for an eye and a tooth for a tooth; and many of the merciful characteristics of the Mosaic legislation are conspicuous by their absence. But within these limitations it doubtless is what Winckler calls it, "one of the most important original sources in the history of mankind in general."

The original text, together with a French translation, is published by the Assyriologist of the expedition, P. V. Scheil, in the fourth volume of the "Délégation en Perse," the official narrative of the expedition. There is a remarkable monotony in the forms of these laws, each beginning with the word "If," and this peculiarity as well as its stringent measures is suggestive of the Draconian legislation.

The series begins with 128 laws that refer chiefly to property rights and business affairs. Of these here are some that are characteristic:

2. If anybody raises a suspicion against another and he against whom this suspicion has been raised goes down to the river and jumps into the water, and if then the river seizes him, then he who has charged him can take possession of his property. But if the river declares him to be guiltless and he remains unhurt, then he who has raised the false accusation shall be killed and he who has jumped into the river shall have the property of his accuser.

5. If a Judge has charge of a trial and passes a judgment and this judgment has been given effect, and if afterward it turns out that this judgment has been false and the Judge is then convicted of having given a false decision, then he shall return the fine he has inflicted twelvefold and he shall be deprived of his office as Judge and shall never return to this office.

6. If anybody robs either the temple or the royal palace he shall be killed; and he who has received such stolen goods shall also be killed.

15. If anybody takes out of the city gate the male or the female slave of the palace or of a freedman he shall be killed.

21. If anybody breaks a hole into a house he shall be killed in front of this hole and shall be burned there.

48. If anybody has a debt to pay, and a storm destroys his land, or the harvest is wrecked, or there has been a lack of water, then he is not obliged to pay the owner any grain for this year nor shall he be compelled to pay interest.

108. If the [woman] keeper of an inn harbors in her place those who conspire and does not report them, then she shall be killed.

117. If anybody cannot pay his debts then he can give his wife or son or daughter into the house of the creditor to serve for three years, but in the fourth year they shall be free.

132. If the finger [suspicion] has been raised against the wife of a man, but she has not been proved guilty, then she shall for the sake of her husband jump into the water.

141. If anybody's wife, who lives in his house, proposes to leave it and has been guilty of squandering and making debts, and neglects her husband, then she shall be brought before the courts; and if the husband then pronounces her divorce, she shall go her way, but receive nothing. If the husband does not divorce her, then she shall be a servant in the house of her husband.

168. If anybody desires to discard his son, and he says before the Judge, "I desire to discard my son," then the Judge shall examine his reasons, and if the son

has not been guilty of great wrongs which justify his rejection as son, then his father shall not reject him.

169. If on the other hand, he has been guilty, then the first time it shall be forgiven him; but if he is for a second time guilty, then the rejection shall follow.

195. If a son strikes his own father, his hands shall be hewn off.

196. If anybody strikes out the eye of another, his own eye shall be forfeited.

197. If anybody breaks the bone of another, his bone, too, shall be broken.

200. If anybody destroys the teeth of his equal, his teeth, too, shall be broken.

215. If a surgeon causes a severe wound with his knife, he shall be fined ten shekels of gold.

218. If a surgeon through his operation causes death for the patient, he shall be killed.

229. If a builder erects a house for another, and it is not well made and it falls down and kills the owner, then the builder shall be killed.

245. If a person hires an ox and by his bad treatment kills the animal, he shall give the owner another ox in the place of the first.

282. If a slave say to his master: "Thou art not my master!" then his lord shall cut off his ear.

In the conclusion of this code Hammurabi repeatedly calls himself "King of Righteousness," as did his contemporary Melchisedek of Jerusalem, and enjoins upon all of his successors upon the throne to observe this code and its laws.

THE FIRST INHABITANTS OF THE HOLY LAND.

By the ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THE Palestine Exploration Fund has issued a report dealing with the latest results of the archæological and other researches in Palestine, carried out under their auspices, the most important of which is that dealing with the investigations conducted by Prof. R. A. S. Macalister, who has obtained new and highly interesting information relative to the original inhabitants of the Holy Land. Prof. Macalister has been carrying out for some time past excavations at Tel-el-Jezari near Abu-Shuseh, on the right-hand side of the road leading from Jaffa to Jerusalem. This site has long been decided as that of Gezer, the old Canaanite city whose inhabitants and king were slain by Joshua. This ancient city was built upon a mound more than 1,800 feet in length, rising at each end into knolls, which in all probability were the tops of low natural hills, with an intervening depression. The latter is now filled with debris. Prof. Macalister confined his excavations to the eastern half of this mound, but he discovered that the entire site had been surrounded by a wall. He dug trenches into the thicker debris to a depth sometimes of nearly twenty feet and discovered three well-marked series of ancient walls, besides one less perfectly defined of earlier date.

The walls were evidently built in a very crude manner, as the stones employed in their construction are very rough, and had only undergone a simple hammer dressing. Some of the stones were of the size of pebbles, while others were huge bowlders, thus testifying to the unmethodical manner in which the building operations had been carried out. At places sundried bricks were discovered—more abundantly in the third series of walls—while furthermore, floors composed of beaten mud and limestone were unearthed. Prof. Macalister passed over the buildings which appeared to be of more recent date, and confined his energies to a stratification which he observed in the walls, comprising four layers in all, though difficulty was experienced in determining which were the earlier layers. The average thickness of the outer and larger walls of the city is 14 feet, and in places portions of the wall 12 feet in height have been unearthed. On the outer and inner sides of this inclosure towers were found. Running in a rough parallel direction to this wall is another, of earlier date, but not quite so thick, and dating from the first or second city, while the walls which are more methodically built, and composed of better-dressed stones, belong to the third or fourth city. Within the walls was found a remarkable four-sided inclosure built of stone, which from its appearance and style is associated with the period of the early walls. The western half of this inclosure is subdivided by walls, while the eastern portion incloses a circle of stones about eighteen inches in diameter, cemented together with beaten mud, and erected on a small platform or dais composed of the same material. Several pillar stones, which it is opined were utilized either as memorials or sacrificial altars, were also found at various levels, together with a few unhewn monoliths, the largest of which were 14 feet in height. The purposes for which these obelisks were employed has not yet been definitely ascertained, but it is believed that they were either used as memorials or for sacrificial purposes; the latter theory is supported by the fact that under a pavement near where the monoliths were found, jars containing charred infants' bones were unearthed.

Prof. Macalister also made another discovery. These were two large caves, one of which was found beneath the third city, though it apparently belonged to a date anterior to the wall, since the latter is built across the cave. The cavern was not a natural depression, but had been excavated by the inhabitants of the epoch to which it belonged. Access was gained down a flight of steps, and at the end opposite the entrance to the cavern is a circular shaft. This subterranean chamber is about 30 feet in length and 24 feet in width. Its general appearance suggested a burial place of great antiquity, so the archæologist examined it with infinite care. The floor for rather more than its entire area was buried under a thick layer of fine ashes, often 12 inches in thickness, which on examination proved to be those of human bodies, while a number of half-charred bones were also found. Prof. Macalister is of opinion that this cavern was utilized as a crematorium by the citizens. Furthermore, it was at one time, probably of the period to which the third city wall belonged, used for inhumation. The bodies of the dead were then deposited in the cavern, apparently in a crouching position for the most part, all over the floor. Round the walls, however, a number of small recesses were discovered, in which the bodies of more distinguished persons had been laid to rest.

The second cave had been utilized for a widely different purpose. Its excavation has not yet been completed, but the work so far carried out proves that it is bell-shaped and that it had been used by the latest inhabitants of the city as a cistern or reservoir for water. Yet it had not always been devoted to this object, since six skeletons were discovered, five of them in a crouching attitude, while the sixth, the upper half of which was found, showed that the body, which was that of a girl, had been sawn or hacked in two. The heads of two girls who had been decapitated were also unearthed, which somewhat lends color to the fact that this cavern was also at one period employed for human sacrifices.

Prof. Macalister furthermore found in the course of his excavations a number of other bodies, and pieces of pottery, at varying depths in the debris of the ancient city; and from these relics he has been able to allocate and determine the original and successive inhabitants of the city. The first citizens were somewhat short in stature, averaging for the most part 5 feet 4 inches in height, while in no case did they exceed 5 feet 7 inches in height. Their build too was rather slender, and the skulls that Prof. Macalister discovered were thick and heavy, and of a rather long oval form. On the whole, they bore a very striking resemblance to the first inhabitants of Europe in the Neolithic age.

FIG. 1.
THE SUN-GOD.

FIG. 2.
THE GOD SEBAK.

From the uncremated remains of the third or fourth race that inhabited the city, they were slightly bigger than the Neolithic race, the stature of the former averaging 5 feet 6 inches—an inch more than the latter—and the maximum height was approximately 5 feet 11 inches. Their build too was stronger than the Neolithic race, while their faces were longer and their skulls more approaching the circular shape. Prof. Macalister is of opinion that this latter race belonged to the first wave of Semitic immigration into Palestine.

A large quantity of pottery has been found, which further supports the thesis of the professor as to the first inhabitants of Palestine. That pertaining to the Neolithic race is very coarse and crude in its shaping and manufacture, but improves in both qualities with successive epochs, testifying to an introduction of civilization, or at least, a certain acquaintance with the arts and crafts, but it is remarkable that no connection whatsoever is found with either the Phœnician or Egyptian period.

From the results of these investigations by Prof. Macalister, which however are still far from complete, as a large portion of the fortress hill of Gezer is yet awaiting excavation, conclusive data is obtained that the first inhabitants of Palestine were a Neolithic race, who cremated their dead. This people erected the outer wall, thus converting the mound into a fortress. Their successors were of the primitive Semitic race of the Copper and Bronze epochs, and they erected a second and stronger wall outside the original inclosure. This race in turn was followed by two other Semitic peoples, the first of which, according to the inscriptions upon the scarabs that have been found, occupied Gezer about 2000 B. C. One of the last two races was evidently of a commercial and trading instinct, since from relics that have been found, communication and trading were maintained with both Egypt and Babylon. Commerce with Egypt is extremely probable, for it has long been established that the Egyptians held dominion over Palestine some sixteen centuries before the birth of the Christian era. Yet the pottery unearthed by Prof. Macalister does not betray any sign of Egyptian influence, which still further tends to prove that Palestine was inhabited by an aboriginal race several centuries before Egypt attained the zenith of its glory and power.

THE OKAPI IN ANCIENT EGYPT.

IN a former number of our paper we published a note about the okapi, an animal recently discovered in the heart of Africa. The discovery of such a large land animal is in itself sufficiently striking, but further interest is now added to it by some observations published in Umschau by Prof. Wiedemann, regarding the occurrence in ancient Egyptian records of images representing the okapi.

The question he says, naturally arises, whether the okapi has been quite unknown to all civilized races hitherto, or whether, as in the case of the gorilla, the accounts given of it by natives well acquainted with it have been misconstrued. The country most likely to yield information of this nature is of course Egypt, rich as it is in inscriptions and carved images of men, animals and mythological figures. If the okapi does not occur in Egypt now, it does not follow that it never did. Not only the introduction of certain species, such as the horse, but also the disappearance of others, in Egypt, has been proved beyond doubt.

The hippopotamus and the crocodile did not succumb to the growing culture and persecutions of man until the nineteenth century, but other animals had to yield much earlier. The lion was still pretty common in the second century B. C., but after that he practically disappears. In ancient Egypt, about 3000 B. C., gazelles were quite numerous, and were domesticated and sold along with sheep and cattle in the markets. Their number gradually diminished, and they finally disappeared from the list of domestic animals. Still earlier the elephant and ostrich retreated from the land, animals that must have been common in the Negada period, as is shown by drawings on pots and slates dating from that time, that is, from an era preceding the building of the great pyramids. And probably earlier still the elephant and the giraffe were driven out, for the former appears only in diagrammatic representation as a hieroglyphic sign, while the latter does occur as a real copy from life, not as an indigenous type, however, but as tribute paid by southern Ethiopian races. The okapi may well have vanished at an early period, like the elephant and the giraffe, for it is a timid animal and difficult to catch. It has been impossible to demonstrate its presence in historical times; but it has been traced in the mythological inscriptions of the ancient Egyptians.

The old Egyptians imagined that their deity, in order to take up his abode on earth in the midst of his worshipers, assumed the shape of various animals. They therefore often represented their gods as animals, or distinguished them by picturing them as possessing an animal's head upon a human body. Thus, for instance, the sun god (Fig. 1) bears the head of his incarnation—the hawk; the god Sebak has a crocodile's head (Fig. 2), and the goddess Bast has a cat's head. But among these heads of deities there was one which puzzled the savants a good deal, as it could not readily be ascribed to any living animal; this was the head of the god Set, which is shown in Fig. 3.

This god Set, according to the most widespread Egyptian myth, is a brother of the chief ruler of the gods Osiris, who is always represented in human form. Osiris was regarded as the spender of all blessing and culture. The two brothers had a quarrel. Set killed Osiris and attempted to kill his son Horus also; but through the protection of his mother the latter escaped injury, and when grown up proceeded to war against Set to revenge his father. According to one version the struggle ended in an agreement by which

FIG. 3.—THE GOD SET'S HEAD.

FIG. 4.—THE GOD SET.

Set received lower Egypt, while upper Egypt fell to the lot of Horus. But the more generally accepted story is that Set was expelled, while Horus became sole ruler of the land. Set, however, was not killed, but remained god of the desert, the desert which by its continual encroaching upon the land threatens to destroy the prosperity of Egypt. He was regarded as equal with the gods of the foreign nations who would not stoop to Pharaoh's sway. The attitude of the people toward this deity has varied with the times. In the earlier periods he was in general disrepute,

his images were even occasionally destroyed; in later days he was highly honored, and Pharaoh himself was the earthly representative of the gods Set and Horus. At this time the animal representing Set was depicted in its entirety, while later the head alone appears. But these complete pictures tell nothing more than that the animal was a fairly big quadruped, whose tail is forked at the end, or actually, no doubt, ends in a tuft of hair.

This animal's head is set upon a neck which slants off toward the body; the face is long and thin (Figs. 3 and 4). Over the eyes the forehead has two bony projections. The ears are long. The insertion of the external ear in some drawings is narrow; the upper edge of the ears is almost a straight line, which last characteristic, however, is in all probability due to a conventionalism or to artificial modification in captive individuals, for such square tips of the ears are unknown in any living species. When the animal's color is alluded to it is described as yellow, or more strictly red.

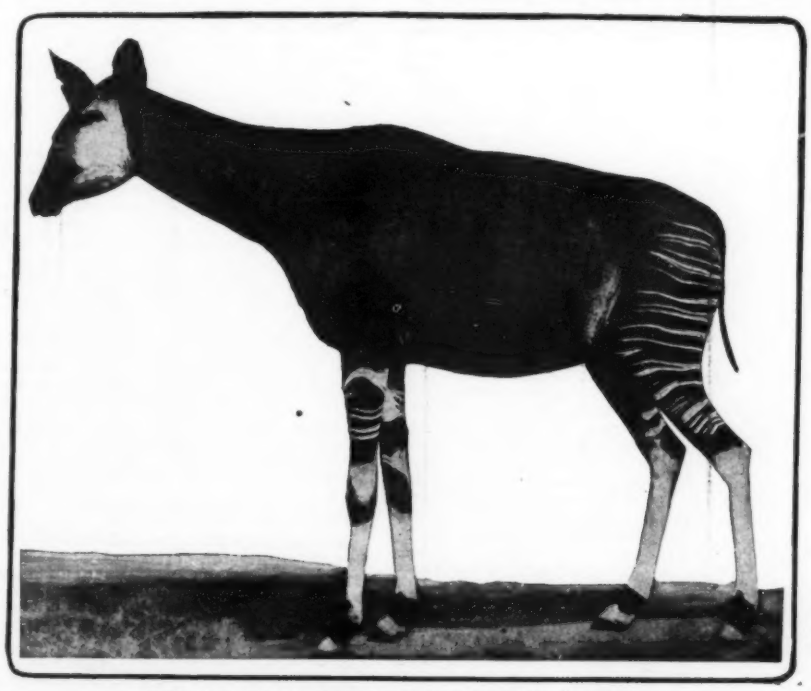
This Set's head has been ascribed to a variety of different animals, but none of these seemed to tally well in their characteristics with the representation. The discovery of the okapi removes the difficulty, for in all essential points, the Set's head is a faithful copy of the okapi's.

No doubt the okapi must early have disappeared from among the Egyptians. This is proved by the rigid adherence to one type in representing the animal, and by its complete absence from hunting scenes. Only in those found in the tombs of Benihassan is it visible, but in that instance the artist was not representing animals actually occurring in the desert; he was rendering an imaginary chase of such animals as were reported to live in the desert. And into the desert the okapi would retreat on finding itself hunted more and more in the Nile valley. In this way it may have come to serve for the impersonation of the god of the desert. Later, when all trace of the actual model of the Set's head was lost, the animal in question was confounded with the wild ass, which actually does resemble the okapi in outline. In this connection the myth originated that Set, after being defeated by Horus, fled for seven days upon a wild ass; and the same cause may account for the legend according to which all the Jewish worship was addressed to a golden ass's head erected in the Temple at Jerusalem.

Even in the times of the Greeks and Romans all knowledge of the okapi was lost. To the courage of the pioneers who are opening up the wild tracts of central Africa it was given to prove the actual existence of the animal whose form, for nearly fifty centuries, has been handed down the generations in mythological tradition.

THE WHORLS OF HAIR ON THE HORSE.

IN KNOWLEDGE, in the course of an article on "Whorls and Crests of Hair as Animal Pedometers," Dr. Walter Kidd writes as follows: "The best examples of the phenomena in question, and the greatest number, are found on the coat of the domestic horse. The best known is that graceful feathering which passes upward in the hollow of the flank, dividing the trunk of the animal from the great rounded mass of muscle of the hind-quarters, and the feathering presents a direction slightly concave forward. It commences at the fold of skin, which passes from the lower part of the abdomen to the hind-limb, by a whorl or vortex of hair. This radiates and expands into a bilateral and symmetrical expansion shaped like the barbs of a feather. The latter proceeds upward in the inguinal hollow as far as the level of the iliac crest, where a projection covered by muscles is always to be recognized, and here it abruptly terminates in a ridge or crest. . . . A better idea of the actual arrangements of the hair-streams will be gathered from an inspection of the coat of any common horse, whose coat is not too long, than can be conveyed by a written description. The symmetry and constancy of this arrangement is very striking and demands explanation. . . . It may be shortly stated that these breaks in the uniform direction of the hairy covering of the horse, and other animals, as well as in other regions of their bodies than the inguinal, are due to the constant traction, during exercise, of underlying and diverging muscles. It is here maintained that they fairly bear the name of pedometers because of the close way in which the degree of locomotive activity is registered according to the persistence, size, and constancy of these otherwise uncalled-for arrangements of hair. When a few horses in the act of trotting are watched, and the main muscles of the horse and the commonest whorls, featherings and crests are borne in mind, it is seen at once that the very conditions required to produce some departure from the ordinary slope of the hairs in the inguinal hollow are present, if indeed it be a possibility that underlying divergent muscular traction should influence the course of the living growing stream of hair on that portion of the skin which lies over the area affected."



THE OKAPI—A NEWLY DISCOVERED ANIMAL.

INVESTIGATIONS OF LUMINOUS BACTERIA.

Two English scientists, Messrs. J. E. Barnard and Allen Macfadyen, for some time past have been carrying out investigations in connection with the natural

HEAD OF THE OKAPI.

luminosity and light production among the lower organisms, otherwise bacteria, and have now published the results and peculiarities observed during their researches. The phenomenon of natural luminosity or phosphorescence is exhibited most strongly by marine animals and minute vegetable cells belonging to the group of bacteria. The light production by living protoplasm is a process closely associated with the life of the organism, as in the case of the luminous bacteria. On the other hand, the luminosity of mineral and other inert bodies is obtained from a purely extraneous source of light. In connection with the light-producing organisms our knowledge of the process is most exact in the case of the bacteria. Their simple semi-cellular structure and the fact that modern bacteriological methods enable the germ to be separated and any particular organism to be examined, render it comparatively easy to investigate the conditions under which light production for the most part occurs. Luminous bacteria are to be found in sea water and on dead marine animals, and are widely distributed. These two scientists devoted their energies to the investigation of some twenty-five of the most important types. The higher forms of marine life, and not bacteria, at any rate in northern latitudes, are to the greatest extent responsible for the luminosity of the sea, but the phosphorescence of dead objects, such as fish, is entirely the result of germs. Messrs. Barnard and Macfadyen have made an interesting communication regarding the general theory that luminous bacteria have direct infective properties as regards crabs and other marine animals, since their investigations failed to substantiate this thesis. They also discovered that it is only under certain exact conditions that these organisms will display their phosphorescent properties by the use of a suitable nutrient medium containing such proportions of salts as shall render it isotonic. A splendid chemical for this purpose is sodic chloride, if present to the extent of 3 per cent, since it will render the organisms luminous for a sufficient time to enable them to be readily cultivated and studied in the laboratory. From the results of these researches it is evident that the luminosity is a function of the living cell, and can be disturbed by any process which interferes with the vitality of the cell itself. The dead cell will not produce light, while antiseptics which kill the cells inhibit at the same time their luminosity. When the organisms are deprived of oxygen, although it does not kill them, they cease to be luminous, so that to obtain light production oxygen is necessary. From their observations, the scientists obtained no evidence of a bacterial product as the source of light, and it is consequently apparent that the process is due to the result of an active oxidation occurring within the cell. The light produced is confined to a small portion of a visible spectrum, and invisible radiations have not been detected. It is assumed that the light is produced without heat, because the spectrum of none of these organisms extends even to the red; no heat radiations are apparently emitted. Though invisible radiations allied to the X-rays have been detected, and although photographs have been obtained by the aid of the light, exposure was necessary for the purpose. An exposure to the temperature of liquid air does not destroy the luminosity of the organisms. It has been found possible to triturate bacteria at the temperature of liquid air, and the luminous bacteria mechanically broken up in this manner ceased to be luminous, which indicated that the luminosity is due to vital processes in the cell, and essentially depends for its origin on the intact organism of the cell.

RICKARDITE; A NEW MINERAL.

By W. E. FORD.

THE new mineral to be described in this paper was first brought to the writer's attention by Mr. T. A. Rickard, of New York. A qualitative examination proved that it contained copper and tellurium, and no such combination having been hitherto described, the mineral seemed worthy of investigation. Through the courtesy of Mr. Rickard, sufficient material was afterward obtained for making a quantitative analysis, the results of which are given below.

Rickardite occurs at Vulcan, Col., in the Good Hope mine, owned by Dr. Loui Weiss. The vein mineral is chiefly pyrite, with which occurs native tellurium in unusually large masses, some of which measure fully three inches across. Other associated minerals are petzite, berthierite in imbedded prisms resembling stibnite, and a greenish-brown micaceous substance, perhaps roscoelite. A large body of native sulphur also was found in the vein. Rickardite itself occurs in small lens-shaped masses, generally rather intimately associated with native tellurium.

The material for analysis was broken up and carefully gone over by hand to free it from any adhering gangue, and only perfectly clean and homogeneous fragments were used. The method of analysis was simple. The powdered mineral was oxidized by nitric acid, which was subsequently removed by evaporation with sulphuric acid. To the strong sulphuric acid solution a liberal amount of hydrochloric acid was added, and then sulphur dioxide gas was led into the solution, which precipitated the tellurium in a metallic form. This precipitate was filtered on to a Gooch crucible, dried in the air-bath at 100 deg. C., and then weighed. In the filtrate copper was precipitated by hydrogen sulphide and determined as cuprous sulphide by igniting in a stream of hydrogen. Careful tests were made for gold, silver, lead, selenium, sulphur, arsenic, and antimony, with only negative results.

The analysis follows:

	I.	II.	Average.	Atomic ratios.
Cu =	40.68	40.81	40.74	0.6409=4.00
Te =	59.36	59.06	59.21	0.4737=2.93
Total	100.04	99.87	99.95	

These results give the ratio Cu: Te = 4.00: 2.93, or very nearly 4.00: 3.00, and the formula for Rickardite therefore is Cu_4Te_3. This gives the theoretical composition of the mineral, Cu = 40.51; Te = 59.49, which agrees very closely with the analytical determination. Rickardite is therefore not only a new mineral but also a new type of telluride, for no such four to three relation between metal and tellurium has hitherto been noted in the group of tellurides. The mineral may be regarded as consisting of one molecule of cuprous telluride and two of cupric telluride, $Cu_2Te.2CuTe$.

Rickardite has an unusual and beautiful purple color, which rivals in intensity the deepest purple tarnish ever seen on chalcopyrite or bornite. The color, however, in the case of Rickardite is not due to any tarnish, for it shows on a fresh fracture, and the powder of the mineral, even when ground very fine, is of the same deep color. The mineral is massive in character, with an irregular fracture. Its hardness is 3.5 and its specific gravity was determined as 7.54. It is fusible at 1 and gives a pale azure blue flame color tinged in the outer parts with green. Alone on charcoal before the blowpipe it gives a white coating of TeO_2 and fuses to a brittle globule of copper telluride. Fused with sodium carbonate and borax on charcoal it gives a coating of TeO_2 and a brittle globule of telluride, yielding only with considerable difficulty a malleable globule of copper. Roasted in the open tube the mineral fuses to a semi-transparent mass of brown color, which is apparently some combination of the oxides of tellurium and copper, and only a faint sublimate of TeO_2 is formed on the walls of the tube. Heated in the closed tube it fuses and undergoes no further change. Heated in concentrated sulphuric acid it gives the characteristic reddish-violet color of tellurium. When dissolved in nitric acid, the solution

neutralized with ammonium hydroxide gives the deep blue color of copper.

It is a pleasure to name the mineral Rickardite, after Mr. T. A. Rickard, the editor of the Engineering and Mining Journal of New York, who obtained the material for investigation and supplied the data as to its occurrence. Thanks are also due Dr. Weiss, of the Good Hope mine, who has been careful to secure all specimens which might be of scientific interest. In conclusion, the writer wishes to express his indebtedness to Prof. S. L. Penfield for his constant advice and assistance during the preparation of this article.—American Journal of Science, (4), xv., No. 85.

NEW DIAMOND FIELDS.

SOME German capitalists of Bremen, headed by Senator Achelis, says the New York Sun, have formed a syndicate to work the diamond fields that have recently been discovered in German Southwest Africa.

The German newspapers say that it is hoped to develop another Kimberley in this region and to destroy the monopoly at present enjoyed by the great De Beers Company.

The discovery of diamonds in German Southwest Africa is quite recent, and little has been made known about this new source of wealth in that colony except that the fields are situated among the mountains in the central part of the colony.

It has long been known that Kimberley could not permanently have a monopoly of the diamond trade. At present it supplies most of the diamonds in the market; but there are several other fields in South Africa that promise well, though little or nothing has yet been done to develop them.

The Australians also are beginning to work diamond mines in New South Wales, which promise rich returns. The fields of Brazil, at one time the great source of supply, are quite certain to be as productive as ever when modern methods of diamond mining, backed by abundant capital, are introduced there.

Very little has been done to develop diamond mining along the banks of the Vaal River in South Africa, where the diamonds of that country were first discovered. Mines were opened there and they yielded abundantly for two years, until the marvelous richness of the beds at Kimberley was revealed, in 1869.

The Vaal River is of very little use to the navigators, but it has rolled down in its water great treasure in diamonds, which led to the discovery of this great source of riches. The Boer farmers often observed the sparkling stones, "mooi klippe," as they called them, along the Vaal River, but never suspected that they were diamonds.

A Boer farmer named Schalk van Niekerk was calling one day at the house of a friend, and, seeing the children playing with a pretty stone, expressed his admiration of it. Their mother presented it to him. This was in 1867.

He showed it to a trader named John O'Reilly, who, suspecting that it was more valuable than a mere crystal, took it to Cape Town for examination. The stone was pronounced to be a diamond, and it was sold to the Governor of Cape Colony, Sir Philip Wodehouse, for $2,500.

It was two years later that the famous "Star of South Africa," now in possession of the Countess of Dudley, was obtained from a Kaffir sorcerer, who had used it as one of his adornments. This stone weighed uncut eighty-three carats and sold for $55,000.

Far north of the Vaal River along the banks of the Limpopo or Crocodile River, the boundary between the Transvaal colony and Mashona Land, diamonds have been found, though nothing whatever as yet has been done to exploit this field. For all that is known, the region along this river is as rich in diamonds as the Vaal.

Diamonds have also been found among the mountains of the Transvaal, also at two points in Cape Colony at Dutoitspan, only two miles to the southeast of Kimberley, and at Bultfontein. These diggings are less than a quarter of a mile apart.

Two diamond centers have also been discovered in the western part of the Orange River Colony, one of which, Jager's Fontein, eighty miles from Kimberley, has yielded about $250,000 a year including many fine diamonds. Most of these regions are entirely undeveloped, because the whole interest centered in Kimberley after its richness was discovered. The time is coming, however, when these other districts will receive the attention they deserve.

Perhaps the Kimberley mines will never be equaled, but it is quite certain that they will not continue to monopolize the industry. The entire product of this field up to the present year for a period of about thirty-five years is little over fifteen tons of diamonds, having a value in excess of $500,000,000.

In a lecture before Harvard and Yale last winter John Hays Hammond, the famous mining expert, said that a box about eight feet square would contain all these diamonds, the net result of mining over 100,000,000 tons of rock, besides the millions of tons of earth moved in exploratory and dead work. The life of the mines cannot yet be determined, but diamond mining in Kimberley undoubtedly will continue for many years to come.

The largest diamond ever discovered is still in the hands of the De Beers Company, for as yet no bidders have been found for this white elephant. It was found on July 2, 1893. It weighs nearly 1,000 carats in the rough, or about half a pound avoirdupois, and is 3½ inches long, about as large as an average goose egg.

It is impossible to determine the value of a diamond of this size. It is of good color, but would not cut well. Diamonds lose from 40 to 60 per cent of their size in cutting.

Some idea of the value of this great stone may be suggested by the fact that a diamond of only 180 carats was sold a few years ago by the De Beers Company for $750,000. As diamonds increase greatly in value with increase of size, the larger stone is supposed to be worth several times that sum. Perhaps the prize will some day fall into the hands of one of the Indian or other Oriental nabobs, who, as is well known, have many of the finest diamonds in their collections.

There is a curious fact connected with the finding of this great stone which illustrates the vicissitudes of diamond mining. The late Barney Barnato had a contract with the De Beers Company for its entire output from noon, July 2, 1892, to noon, July 2, 1893. He quit the mine when the last minute of his contract time expired, and three hours later the new syndicate which succeeded him in the work found the largest diamond ever discovered.

THE SUN'S VEIL.

MISS AGNES M. CLERKE contributes to Knowledge a thoughtful article on the mystery of the sun's protective envelope. "None of the solar appurtenances," she says, "is more obvious to inspection than the screen of attenuated matter overspreading the photosphere. Already, in 1612, Lucas Valerius recognized the darkening of the sun's limb which results from its action. Bouguer, more than a century later, measured the gradations of darkening; Laplace calculated, from the basis of Bouguer's measures, the total amount of light-stoppage in the so-called atmosphere; and Father Secchi perceived the stoppage to be selective, the surviving marginal rays showing a rufous hue. Moreover, since these are very imperfectly actinic, photographs of the sun exhibit the edges of the disk as much more obscure than they appear to the eye. The solar and terrestrial atmospheres are then so far alike that both are heavily absorptive of blue light, while transmitting red and yellow beams with comparative freedom. Yet it does not follow that the sun resembles the earth in being surrounded by an envelope of refrigerated gases. This is indeed impossible under the given conditions. Let us briefly recall their nature. The sun's tinted screen must be situated in the immediate neighborhood of the photosphere. Faculæ visibly overtop it; their upper sections escape the dimming effects of its intervention. They seem like half-submerged stakes in a tideway, that serve, not only to mark the channel, but to show the depth of the water. Now faculæ themselves can be readily located. They are clearly photospheric protuberances. This relationship attests itself indeed to the eye, yet still more convincingly by spectroscopic evidence. Facular light is impressed with the whole array of Fraunhofer lines. It escapes none of the absorption exercised by the vaporous layers near the sun. It has then demonstrably been sifted through them. Faculæ, then, rise from the photosphere, surmount the screening envelope, and are immersed in the reversing stratum. A vaporous layer, however, lying between the reversing stratum and the photosphere, should necessarily be incandescent; and incandescent gases stop only special luminous vibrations; they are incapable of producing a general absorption, such as shadows the solar limb. Hence the interposing veil can only be of a pulverulent composition; cool vapors, placed in the torrid situation where it exists, should, in a few minutes, become glowing; and the action of glowing vapors would be indistinguishable from that of the reversing layers. But whatever its constitution, there can be no doubt as to the importance of its function in the solar economy. Stripped of its 'atmosphere,' the sun would appear fully one stellar magnitude brighter than it usually does. The change might be described as equivalent to the rise of Aldebaran to the rank of Arcturus."

THE DEVICES OF CLIMBING PLANTS.

WRITING in Knowledge on the "Pea Family," Mr. R. Lloyd Praeger observes: "Climbing is a device resorted to by many of our native plants, and by a far larger number in the Tropics, by which, in the keen struggle for light and air, they take advantage of their neighbors to mount on their shoulders, and thus secure an advantageous position. To assist them in climbing, plants adopt various devices, some merely scramble upward, maintaining their position by means of wide spreading leaves or branches; many others use downward-pointing hooks, which anchor them amid the foliage. It is in the twining plants, such as Bryony and Hop, and the tendril-bearers, like the Vetches, that we find the highest development of the climbing habit. These plants live under unusual conditions. In order to gain the light, they must seek, rather than avoid, overhanging foliage; and so we find the Vetches, instead of turning away from the shadow toward the light like most of their neighbors, boldly pushing up into the center of a bush, to burst into blossom amid its upper branches, far above their less daring neighbors. Again, in these plants, supported by their grasp of adjoining branches, the stem no longer needs to act as a supporting column, bearing the weight of the plant and the stress of weather. It acts rather as a conduit through which water and dissolved salts—the raw plant-food—passes upward to the leaves. Hence, instead of being thick and stiff, it is thin and flexible; often wonderfully slender when we consider its length, yet strong and supple, to follow without injury the swaying of the supporting plant. But it is in the leaves of these plants that we find the most remarkable modifications adapting them to a climbing habit. The leaves of the Vetches and Vetchlings are pinnate—they bear a number of opposite ovate leaflets. The tip of the leaf-stalk, and the uppermost pair of pinnæ, are in the climbing species changed into tendrils—sensitive, twining, whip-like structures, which exhibit remarkable features. If the slightly curved, extended tendril of a 'young leaf of Pea or Vetch be watched carefully, it will be found that it is slowly but incessantly moving round and round in a circle. If the tendril comes into contact with a twig, it bends toward it, and eventually takes several turns round it. Even a slight temporary irritation is sufficient to cause a bending toward any side. Finally the tendril becomes woody and strong, and forms a secure anchor-cable for the plant. Not only does the young tendril rotate; the whole leaf on which it is borne is in continual motion. The shoot to which the leaf belongs is rotating also, so that the tendril is sweeping the air with a complicated motion, in the course of which it is almost sure to strike against some stem or twig of the surrounding vegetation."

TRADE NOTES AND RECIPES.

Suggestions About Staining Floors.—The wood to be stained should be clean, smooth and dry. The stain should be tried on a piece of the same kind of wood as that on which it is to be used, because different kinds of woods absorb more or less of the coloring material, as the grain is open or close. The stain may be put on with a brush or with a cloth; some prefer the cloth, because the stain can be rubbed in with it. Measure the surface to be stained, then mix the amount of stain required for that amount of surface. Rub the stain in and let it dry perfectly. It should stand at least twenty-four hours and then be gone over with a woolen cloth wet in linseed oil, rubbing the oil in well. Let this rest twenty-four hours, then rub with a dry woolen cloth; this gives a soft, satin finish.

If a waxed or varnished surface is desired it may be put on after the polishing is done. In mixing colors remember that the coloring matter varies in strength, and that, no matter how closely one follows the rule, it is necessary to try the mixture before putting it on the surface to be stained.

A stain made with one quart of boiled linseed oil, three gills of turpentine and the necessary coloring matter will stain two hundred square feet going over the surface once. If the wood to be stained is open-grained it will require a filler of whiting or starch. Half a pint of either will be sufficient for the amount of stain given above.—Druggists' Circular and Chemical Gazette.

Hektograph.—Soak 4 parts of best white glue in a mixture of 5 parts of water and 3 parts of ammonia water until the glue is thoroughly softened. Warm it until the glue is dissolved, and add 3 parts of granulated sugar and 8 parts of glycerin, stirring well and letting it come to the boiling point. While hot, paint it upon clean white blotting paper, with a broad copying brush, until the blotting paper is thoroughly soaked and a thin coating remains on the surface. Allow it to dry for two or three days and it is then ready for use.

The writing or drawing to be copied is done with ordinary hektograph or anilin ink upon writing paper. Before transferring to the blotting paper, wet the latter with a sponge or copying brush and clean water and allow it to stand one or two minutes. Place the written side down and strike out any air bubbles and submit the whole to gentle pressure for a few moments, remove the written paper and a number of impressions can then be taken in the ordinary way. When the impressions begin to grow weak, wet the surface of the hektograph again.—Druggists' Circular and Chemical Gazette.

Bay Rum.—Bay rum or more properly bay spirit may be made from the oil with weak alcohol as here directed:

Oil of bay leaves	3	drachms
Oil of orange peel	½	drachm
Tincture of orange peel	2	ounces
Magnesium carbonate	½	ounce
Alcohol	4	pints
Water	4	pints

Triturate the oils with the magnesium carbonate, gradually adding the other ingredients previously mixed and filter.

The tincture of orange peel is used chiefly as a coloring for the mixture.

Oil of bay leaves as found in the market varies in quality. The most costly will presumably be found the best, and its use will not make the product expensive. It can be made from the best oil and deodorized alcohol and still sold at a moderate price with a good profit.

Especial care should be taken to use only perfectly fresh oil of orange peel. As is well known, this oil deteriorates rapidly on exposure to the air, acquiring an odor similar to that of turpentine. The oil should be kept in bottles of such size that when opened the contents can be all used in a short time.—Druggists' Circular and Chemical Gazette.

Cement for Mending Pestles.—I. Plaster of Paris is ordinarily used for fastening loose handles. It is made into a moderately thick paste with water, run into the hole in the head of the pestle, the handle inserted and held in place till the cement hardens. Some add sand to the paste, and claim to get better results.

II. Boil together 1 part of caustic soda, 3 parts of rosin and 5 parts of water till homogeneous and add 4 parts of plaster of Paris. The paste sets in half an hour and is but little affected by water.

III. Equal quantities of gutta percha and shellac are melted together and well stirred. This is best done in an iron capsule placed on a sandbath and heated over a gas furnace or on the top of a stove. It is a combination possessing both hardness and toughness, qualities that make it particularly desirable in mending mortars and pestles. In using, the articles to be cemented should be warmed to about the melting point of the mixture and retained in proper position until cool, when they are ready for use.—Druggists' Circular and Chemical Gazette.

Substitute for Putty as a Filler.—A cheap and effective substitute for putty to stop cracks in woodwork is made by soaking newspapers in a paste made by boiling a pound of flour in three quarts of water, and adding a teaspoonful of alum. This mixture should be of about the same consistency as putty, and should be forced into the cracks with a blunt knife. It will harden, like papiermaché, and when dry may be painted or stained to match the boards, when it will be almost imperceptible.—Druggists' Circular and Chemical Gazette.

Applying Paris Green to Vegetables.—So far as we can learn no way has been discovered to make a neutral solution of Paris green or London purple. In suspending Paris green in water for spraying vegetation it is common we are told to add some milk of lime on the supposition that the unmixed arsenical preparation may prove injurious, and that the lime will act as a protective. The presence of the lime probably aids in keeping the green in suspension, its particles perhaps subsiding less readily.—Druggists' Circular and Chemical Gazette.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Introduction of American Automobiles into Switzerland.—Articles published recently in American papers which have reached this consulate show a development in the manufacture of motor cars at home that seems to me to warrant efforts to secure a market for them abroad. I have heard dealers here say that it is only a question of time when they will have to face American competition. The motor cars of a number of manufacturers in the United States are rapidly approaching the requirements of the European market as to type of carriage and price.

It is not generally known that the sale of automobiles is growing fast in Switzerland, especially in this part of the country—i.e., the cantons of Geneva and Vaud; for the canton of Valais, the third canton of this consular district, having but one road accessible (by law) to motor cars along the Rhone Valley and only a small number of inhabitants, is hardly worth taking into consideration.

Geneva, especially, has, in comparison with the cantonal population (135,000), a large number of these modern vehicles (about 280), and in this respect is far ahead of all the other cantons of Switzerland. There are also many motor cycles, and it is estimated that during the coming tourist season the total number of automobiles will be increased to about 400.

Besides their novelty, there are many reasons why these vehicles should be popular here: First, the good and tolerably flat roads around Geneva; second, the charm of the city's environments; third, the proximity of France, where the roads are perfect and automobiling is a flourishing sport; fourth, the ever-increasing number of automobiles "touring" through the city; fifth, the cheapness of benzine, now costing about 24 francs per 100 liters ($4.63 per 26.42 gallons); and sixth, the establishment of energetic firms for the sale and hire of motor cars.

The most popular machines seem to be those of from 6 to 8 horse power, and among them is the 6 horse power French "Voiturette de Dion-Bouton," with two seats, which is sold here at a little under 4,100 francs ($791.30). The firm Perrot, Duval & Co., Geneva, have already disposed of quite a number of these vehicles. They are comparatively light and are capable of making from 45 to 50 kilometers (28 to 31 miles) per hour. I am of opinion that this is the type of automobile which our exporters at home ought to adopt for sale in this country, provided the American machines are strong enough to climb grades of from 8 to 10 per cent.

Four-seated automobiles range in prices from 10,000 to 15,000 francs ($1,930 to $2,895). A few cost about 20,000 francs ($3,860), and I know of one which cost 30,000 francs ($5,790), but the latter is a high price, which will be paid rarely in this country. Ten thousand francs ($1,930) is considered a fair average price for an automobile with four seats.

The demand for automobiles is so great that makers ask a premium of from 1,000 to 5,000 francs ($193 to $965) or even 7,000 francs ($1,351) for prompt delivery.

Larger cars than the de Dion-Bouton "Voitures" and "Voiturettes," from Georges Richard, Clement, Panhard-Levassor, Rochet & Schneider, Darracq, and Krieger (French); Daimler (which is still considered as one of the best, if not the best, here), Adler (German) and Martini (Swiss) are frequently to be seen, their size and price covering a wide range. Most of the motor cars in Geneva are French; they compare with German makes as 4 to 1.

Custom Duties.—Under the existing Swiss tariff carriages of all kinds pay a duty of 20 francs per quintal ($3.86 per 220 pounds); but if the weight of the motor car itself, separate from the total weight of the vehicle, can be stated at the time of importation and proved by a certificate from the builder, the duty on it is assessed at 4 francs (77 cents) per quintal (220 pounds), the remainder of the total weight paying 20 francs per quintal ($3.86 per 220 pounds). It can be safely stated that 100 to 150 or 200 francs ($19.30 to $28.95 or $38.60) will cover the duty.

Motor cyles are assessed at 70 francs per quintal ($13.51 per 220 pounds). The general tariff, which is applied to American goods, raises this figure to 100 francs ($19.30).

The new tariff bill passed by the Federal Chambers at the end of last year, which will be submitted to the nation on the 15th of March next, increases the rate of duty on automobiles from 4 and 20 francs (77 cents and $3.86) to 40 francs ($7.72) net, provided the imported article is not upholstered, and if upholstered, to 60 francs ($11.58) per quintal (220 pounds). This means on a non-upholstered automobile weighing 600 kilogrammes (1,320 pounds) a duty of 240 francs ($46.32), and on the upholstered, of 360 francs ($69.50).

I have been told that the pending tariff will probably not become effective before the beginning of 1904, if accepted by the nation; but the Federal Council has the power to fix the date.

Taxes.—A point of interest is found in the taxation of automobiles, which differs in the various cantons. For instance, the canton of Geneva taxes automobiles, under the head of "vehicles with one horse," 12 francs ($2.31) per year, and adds to this a charge of 5 francs (96 cents) for a cantonal plate number. The neighboring canton of Vaud imposes a yearly tax of 80 francs ($15.44) on a 6 horse power automobile; but each town or village of that canton also has the legal right to tax the same article, and one village levied double the amount of the cantonal tax—i. e., 160 francs ($30.88)—which made a total yearly tax of 240 francs ($46.32). The two owners of automobiles in that village sold their machines immediately.

A measure will shortly be introduced in the Grand Council of Geneva to tax automobiles in this canton as follows:

Description.	Tax. Francs.	
Up to 8 horse power.....	12	$2.31
From 8 to 16 horse power.....	24	4.63
Above 16 horse power.....	50	9.65

Catalogues of American manufacturers, even if they be in the language of the country to which they are sent, are of little effective use when pitted against the samples and agents of European houses. They are seldom carefully examined by the receiver, who invariably prefers to deal with the man on the spot.—Horace Lee Washington, Consul at Geneva.

American Goods in Russian Poland.—On account of various troubles existing in the German Polish provinces, the commercial relations between Russian Poland and Germany have become rather strained, and I learn from leading business men in this city that preference is given to all goods other than those of German manufacture. In fact, there is a distinct tendency to avoid the purchase of German goods whenever practicable, and in view of these conditions France, Austria, and particularly England have largely increased their trade with this part of Russia.

Independently of the above statement, Warsaw, a growing city of nearly 800,000 inhabitants, is considered the center for the importation of goods from foreign countries. Foreign goods, and especially all kinds of machinery, when once adopted in Warsaw, spread rapidly over the empire. Warsaw is only five hours by rail from the German boundary, and from there it is but a day's journey to the principal German seaports—Hamburg, Lübeck, Danzig, and Stettin—while St. Petersburg, through its severe climate, is much less accessible to the trade by sea.

Austria, England, and France have been very busy; their salesmen are continually on the spot, investigating the conditions of trade and making a careful study of local requirements. This should attract the attention of American manufacturers who desire to extend their export trade. I notice that great interest is expressed in goods of American make, and I am confident that there is in this section of Russia a large field for all kinds of American products. So far, the direct importation of American goods is very limited, because no energetic efforts have been made. With the exception of agricultural machinery, the few American goods that are on sale here come through the hands of Hamburg and Berlin commission houses. From conversations had with several large importing concerns in this city, I learn that it would be greatly preferred to avoid the "middleman" and to import direct.

Following is a list of American-made goods which are partly introduced or would find a ready sale in this city: Wringing machines, meat-chopping machines, hair-clipping machines, typewriters, gramophones, safety razors, tools of all kinds for carpenter, locksmith, etc., galvanized iron spoons (in large demand), machinery of all kinds and their parts, jewels (imitation) and chains, sticky fly paper, paper for fancy lamp shades, machine tools, especially labor-saving machinery, cotton and cotton waste, hunting rifles, hydraulic lifts, rubber shoes, light-weight, low; hardware, all kinds; agricultural machinery. (There is a special representative here.) Automobiles for heavy loads.

In regard to automobiles for heavy loads, I am informed that a company is about to be organized in this city with a view to introducing these machines on a large scale, and that it intends to obtain offers from English, French, and Belgian manufacturers. The following concerns desire agencies for American goods: Bronislaw Oderfeld, 17 Ujasdowska Aleja, and Leopold Tennenbaum, 12 Leszno. So far as I can learn, they have a good reputation in this city. Direct correspondence with them is recommended.

There has probably never been a better opportunity for the introduction of American goods into this part of Russia.—Hernando de Soto, Vice-Consul at Warsaw.

American Agencies in Syria.—In order to promote United States trade with Syria and Palestine, I have for several years past worked for the establishment of agencies in the principal commercial centers which would more or less exclusively devote themselves to trade wth the United States, both in exports and imports. Each of these agencies should have sample rooms containing specimens of American manufactures and be the recognized headquarters for commercial transactions with our country. It seems the plan is gradually succeeding, and that Syrian trade with the United States will before long be fairly well organized.

In Beirut, H. Sabbag et Fils are doing business with the United States almost exclusively. They export wool, licorice root, bitumen, rugs, etc., and import agricultural machinery, besides representing a large export house in New York city, which in turn acts for a number of American manufacturers in various lines.

In Haifa, the American Exchange Company was organized a year ago for business with the United States. Haifa commands the trade of Galilee, besides the plains of Esdraelon and Upper Sharon. It is the seat of a colony of foreigners, including some 17 American families, who teach the natives modern methods in agriculture.

In Damascus, Mehsaka & Nachman have during the past winter formed a commercial agency "with the object of furthering American commerce" in that region. An extensive trade is carried on with the Bedouin tribes, who pasture their flocks for hundreds of miles around. The Damascus-Mecca Railway has now reached a point due east of the Dead Sea, and has thus opened up the Hauran district, the granary of Syria, for agricultural machines and implements and other products of civilization. Last autumn, the Beirut-Damascus Railroad Company completed a standard-gage feeder to Homs and Hamath. In the Bekaa plain (Cœle-Syria), as well as in the Hauran and other parts of Syria and Palestine, agriculture is in an extremely backward state. Large tracts of land of great fertility lie waste and depopulated, though showing traces of former prosperity and teeming population. Irrigation and railroads will prove strong factors in the redemption of these regions.

Besides the agencies at Beirut, Haifa, and Damascus, Tripoli is expected soon to have an American agency of its own. I know of nobody in Tripoli more interested in United States goods than John Hakim. In Cyprus the same applies to the house of P. J. Louisides & Co. The promoters of the agencies mentioned are connected in an honorary capacity with the United States consular establishments in the respective places. Michel Nasser, representing H. Sabbag et Fils; T. S. Boutagy, general manager of the American Exchange Company; and M. Meshaka, of Meshaka & Nachman, have all visited the United States within the last two years.

I would also call the attention of American manufacturers to the Syrian Protestant College at Beirut, and especially to its school of commerce, in connection with which a commercial museum is being gradually developed. Any article exhibited will be brought prominently before the peoples of the Levant through the students who come from all parts of Turkey, Greece, Persia, Egypt, and the Sudan. This college is an American non-sectarian institution, with an enrollment at present of 627 students. It has five departments, viz., medicine, pharmacy, commerce, arts, and archæology; with 45 professors and instructors, 28 of whom are native Americans and graduates of American colleges; 14 commodious buildings and a campus of 50 acres. It is perhaps the largest American institution of learning outside the United States; the English language is the principal medium of instruction. American samples and commercial literature should be furnished this institution without stint.—G. Bie Ravndal, Consul at Beirut.

Agricultural Fair at Cüstrin, Germany.—It may be of interest to American manufacturers of agricultural tools and machinery to know that from June 5 to 14, 1903, an agricultural exhibition will be held in Cüstrin, a city situated 52 miles east of Berlin at the joining of the Oder and Warthe rivers. Cüstrin has about 13,000 inhabitants, and the suburb, where the exhibition will be located, is the crossing point of six different railroad lines—one of these, the Berlin-Königsberg line, being the connecting link between the German capital and the far eastern portion of the empire. In the country round about Cüstrin and also in the neighboring provinces agricultural enterprise is widely carried on by farmers and landed proprietors, and American manufacturers should exhibit their best goods in order to secure a fair share of the trade in agricultural tools and machinery. The exhibition has the support of several important agricultural and industrial associations and is the more likely to be a success as it is, as far as I can find out, about the only one that will be held in Germany this year.

I learn that Mr. Max Schleusner, of Cüstrin 2, is a member of the exhibition committee, and further particulars regarding the exhibition will be cheerfully furnished by him to applicants.—Oliver J. D. Hughes, Consul-General at Coburg.

Dresden Exposition of Municipal Government.—Consul-General Charles L. Cole writes from Dresden, February 13, 1903, that an exhibition will be held in that city from May 20 to September 30, 1903, which has for its object the study of improvements in municipal government and welfare. This will include streets, street paving and cleaning, sewers and drainage, gas and electric lighting, bridges, harbors, parks, schools, hospitals, police, cabs, automobiles, and kindred subjects. Invitations are sent to the prominent cities in the United States of America to appoint delegates to this exposition. Further information may be obtained by interested parties by addressing Oberbürgermeister, Geh. Finanzrath a. D. D. Beutler, Dresden, Saxony. Circulars (in German) setting forth the scope of the exhibition, transmitted by the consul-general, are filed for reference in the Bureau of Foreign Commerce.

Increase in Venezuelan Tariff.—The Department has received from Mr. Russell, secretary of legation at Caracas, under date of February 20, 1903, notice that the government of Venezuela, by an executive decree, has created an "extraordinary war tax." There is a 30 per cent increase in the duties on imports. Exports are taxed as follows: For each 50 kilogrammes (110.2 pounds) of coffee, 2 bolivars (38.6 cents); sweet cacao, first quality, 16 bolivars ($3.08) for each 50 kilogrammes; all other qualities of cacao, 6 bolivars ($1.16) for each 50 kilogrammes; cattle hides, 4 bolivars (77.2 cents) for each 46 kilogrammes (101.4 pounds); goat and deer hides, 5 bolivars (96.5 cents) for each 46 kilogrammes.

A Trade Opening in Siam is offered by the railroad department of that country, which on June 15 next, will award contracts for 30,000 tons of rails and of 3,806 other iron materials (spikes, screws, plates, etc.), used for track construction. For detailed information, applicants should address: The Director-General Royal Railway Department, Bangkok, Siam. According to the St. Petersburg (Russia) Journal, the city authorities have determined to build new quays and to deepen the riverbed of the harbor so as to have 28 feet water depth. The costs of this project are estimated to be 26,000,000 rubles (over $13,000,000). American constructors who may wish to learn further particulars would do well to address the United States Consul-General at St. Petersburg.—Simon W. Hanauer, Deputy Consul-General, Frankfort-on-Main.

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No. 1592, March 12.—*Introduction of American Automobiles into Switzerland.

No. 1593, March 13.—*American Goods in Russian Poland—Latest Bundling Press in Germany—Cuban Diplomatic and Consular Service—*Agricultural Fair at Custrin, Germany.—*Silver and Plated Ware in Spain—*Railway-car Plant in Mexico—*Meat-canning Factory in Veracruz.

No. 1594, March 14.—*American Agencies in Syria—The Shortest Trans-Atlantic Steamship Route—Proposed Austro-Hungarian Tariff—Trade of Cuba—Trade of Tasmania—Tariff Change in Persia—*Poultry Exhibition at Rome.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Waterproof Cement.—The Drogisten Zeitung is authority for the following:

Alcohol 95 per cent	1000 parts
Sandarac	60 parts
Mastic	60 parts
Turpentine oil	60 parts

Dissolve the gums in the alcohol and add the oil and stir in. Now prepare a solution of equal parts of glue and isinglass, by soaking 125 parts of each in cold water until it becomes saturated, pouring and pressing off the residue, and melting in the waterbath. This should produce a volume of glue nearly equal to that of the solution of gums. The latter should, in the meantime, have been cautiously raised to the boiling point in the waterbath, and then mixed with the hot glue solution. Articles united with this substance will stand the action of cold water for an unlimited time, and it takes even hot water a long time to affect it.

Deodorising Benzine.—1. To 1,750 parts of water add 250 parts of sulphuric acid, and when it has cooled down add 30 parts of potassium permanganate and let dissolve. Add this solution to 4,500 parts of benzine, stir well together and set aside for 24 hours. Now decant the benzine and to it add a solution of 7½ parts of potassium permanganate and 15 parts of sodium hydrate in 1,000 parts of water, and agitate the substances well together. Let stand until the benzine separates, then draw off.

Or else: 2. Dissolve 3 parts of litharge and 18 parts of sodium hydrate in 40 parts of water. Add this to 200-250 parts of benzine and agitate well together for two minutes, then let settle and draw off the benzine. Rinse the latter by agitating it with plenty of clear water, let settle, draw off the benzine, and if necessary, repeat the operation.

Either process requires considerable work, and unless large quantities of benzine are used, the querist will find it a good deal more profitable to buy the commercial deodorized article.—National Druggist.

To Color Benzine Green.—Probably the simplest and cheapest, as well as the best method of coloring benzine green is to dissolve in it sufficient oil soluble anilin green of the desired tint to give the required shade. As regards "the addition of poisonous substances" to benzine to make it serve as a "bug killer," the pure benzine is deadly to every insect it touches. The writer has used it, in the form of a spray, for a number of years as a cockroach and bed-bug exterminator, and no more instantaneously deadly agent could be imagined. —National Druggist.

Label Varnish.—The following formula makes a good label varnish:

Sandarac	60 parts
Mastic	25 parts
Camphor	1 part
Oil of lavender	8 parts
Venice turpentine	4 parts
Ether	6 parts
Alcohol, 95 per cent	44 parts

Mix and macerate together and set aside to dissolve, giving the container an occasional shake. It takes several days to effect complete solution, but the resultant article is worth the trouble. Thin where necessary with alcohol to which 12 per cent of ether is added, or absolute alcohol alone. The following is also a most excellent article, by some preferred to the above:

Mastic	8 parts
Copaiba balsam	4 parts
Venice turpentine	6 parts
Oil of turpentine	8 parts
Sandarac	24 parts
Alcohol, 95 per cent	80 parts

Mix and let stand in a close vessel until the gums and resins are completely dissolved, facilitating solution by frequent agitation. Let stand a few days, in perfect quiet, then cautiously decant.

As a pointer to the successful use of either of these varnishes, and to secure that brilliant and glossy surface of which either is capable, first varnish the label with thin collodion, giving it two coats, letting the first dry before applying the second.

Neither varnish turns yellow, and when applied to white paint it not only gives it a brilliant luster but protects it from yellowing. A picture frame finished in white and gold was varnished with the second of these varnishes nine years ago, and it looks as well today as when it was first finished.—National Druggist.

Fireproofing Timber.—One of the simplest methods is to saturate the timber with solution of tungstate of soda; if this is done in a vacuum chamber, by means of which the wood is partly deprived of the air contained in its cells, a very satisfactory result will be obtained. Payne's process consists in treating wood under these conditions first with solution of sulphate of iron, and then with chloride of calcium; calcium sulphate is thus precipitated in the tissues of the timber, which is rendered incombustible and much more durable. There are several other methods besides these, phosphate of ammonia and tungstates being most useful. A coat of common whitewash is an excellent means of lessening the combustibility of soft wood.—Pharm. Era.

Toilet Cream for Applying to the Skin or Hair.—

White wax	6 parts
Tallow, freshly tried out	4 parts
Spermaceti	2 parts
Oil of sweet almonds	6 parts

Melt together and while still hot, add with constant stirring, one part of sodium carbonate dissolved in seventy-nine parts of hot water. Stir until cold. Perfume to the taste.—Pharm. Era.

Myrrh Toothpaste.—

Precipitated chalk	8 ounces
Orris	8 ounces
White castile soap	2 ounces
Borax	2 ounces
Myrrh	1 ounce
Glycerin	q. s.

Color and perfume to suit.—Pharm. Era.

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